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ABSTRACT

These resource magazines for K-6 educators are published to promote the teaching of science, mathematics, and technology through participatory. inquiry-based methods. Each issue provides resources and hands-on activities for educators that focus on one theme. Issues in volume 5 cover the themes of geology, math and science integration, tropical rainforests, and water, respectively. Each issue contains sections with the following information related to the issue's topic: (1) introduction to the topic area and its importance; (2) description of a highlighted teaching strategy and activity; (3) an annotated list of books with appropriate grade level indicated; (4) background information; (5) a list of video, computer, and curriculum materials available (contains a special section on inexpensive materials); and (6) 10-12 science activities with objectives, materials, and procedures sections. (LZ)

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ED 378 034

Science • *is* ELEMENTARY

Vol. 5, No. 1

A SCIENCE TEACHING RESOURCE PUBLICATION

In this issue

Geology

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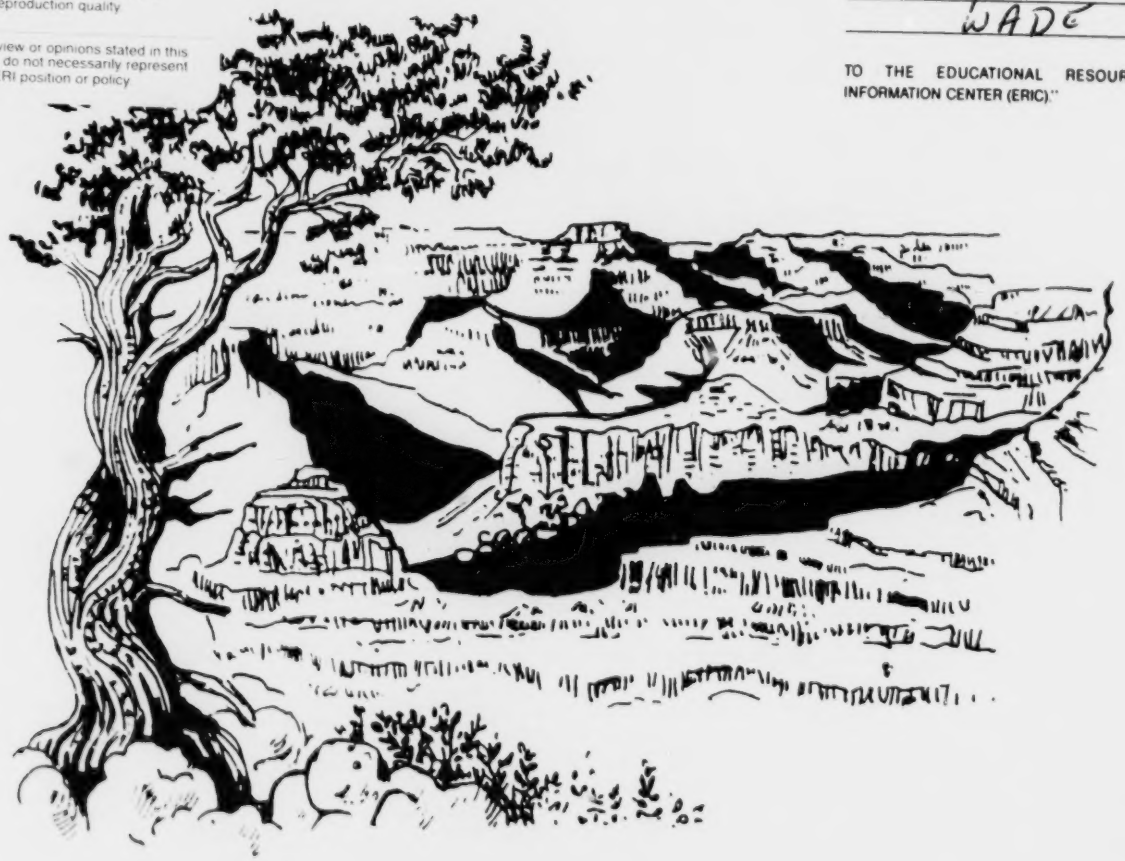

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Geology

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Volume 4 of *Science is Elementary*, published during 1991, contains the following topics:

No. 1 "Animals/Anatomy"
No. 2 "Conservation"
No. 3 "Newton's Laws"
No. 4 "Bottle Biology and LEAP"

Volume 5 of *Science is Elementary*, published during 1992, will include the following issues:

No. 1 "Geology"
No. 2 "Mathematics & Science Integration"
No. 3 "Tropical Rain Forests"
No. 4 "The Water Planet"

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Mission • *Science is* ELEMENTARY

The Museum Institute for Teaching Science was started in 1983 as a collaboration of seven (then eleven) museums across Massachusetts for the purpose of increasing and improving the teaching of science in elementary and middle schools. From 1986-1991 under the leadership of Frank Gardner, Executive Director of MITS, a series of successful workshops were presented and the resource publication for teachers, *Science is Elementary*, was developed. These activities were funded by the National Science Foundation, the federal Department of Education and private foundations and corporations. Early in 1992, the directors of the collaborating museums advised that it was time for MITS, Inc. to become a separate entity.

MITS, Inc. was incorporated in June of 1992. The purpose remains: the teaching of participatory, inquiry-based science, math and technology in elementary and middle schools. This goal is achieved by promoting cooperative ventures between institutions of higher learning, museums, businesses, federal and state agencies, and schools. These ventures include workshops, conferences, and a resource publication to promote continuing professional development for teachers, museum educators and school administrators.

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Brief Brief

This is the first issue of Volume Five, and I never would have believed six years ago that I would still be sitting here. SCIENCE IS ELEMENTARY has undergone many changes. Changes in content, layout and personnel involved. The only constant has been me. I have found this project to be rewarding, informative, frustrating and endless; but always exciting. Please let us know what you think. We welcome ideas for activities or projects, thoughts on issues you'd like to see done, or lines to free and inexpensive resources you've come across.

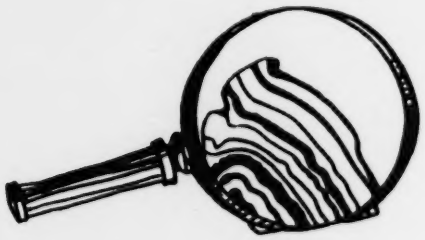
We are no longer using the feature *What's New*. There are so many magazines it would take endless hours perusing them all. I suggest you visit your local library, museum library, college library, curriculum center, or newsstand to see what's new in the field of science publications. Most magazines publish an index in their last issue of the year. This will help you pinpoint articles on specific topics. Try making a monthly sojourn through the pages of science magazines and you'll be amazed at what you can learn.

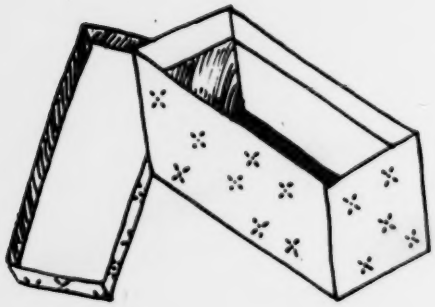
This issue on geology is an update of an issue we published in Volume 3. It contains old and new activities and updated background information. Geology was our most requested issue. The *Trade Secret* section features information on kit making, a highly requested topic. Use any issue of SIE to make into a classroom kit. All the information is included - you just have to collect the materials, pictures, etc.

The Museum Institute for Teaching Science has been recently incorporated as a non-profit organization. A summer workshop component is in the planning stages and we will be working closely as liason between museums and the state department of education initiatives in mathematics and science education. We have moved our offices to 79 Milk Street in Boston during July. BW

One of the trade secrets museums use is the **kit** Kits range in size, style and content, but are not difficult to make with some careful thought and preparation. Every teacher has a "stash" of items, pictures, or activity ideas on a particular topic of interest - whales, rainbows, penguins, etc. Check a file or the back of the closet. It is best to start with items with which you are already familiar. By simply gathering these materials together, or collecting materials listed in any issue of *Science is Elementary*, you have a jumping off place.

Kits can be based on a topic you want to expand - bears, or a question you want to answer, "What is a phenokistoscope?" Teams of teachers can develop a kit to be used across grade levels, or students can develop kits for project-based assessment. Kits can be kept in-house or travel city-wide. However you decide to develop yours, there are a few questions you must think about before proceeding. These will help to focus ideas and streamline preparation. It is best not to take on too big a topic when first starting out. A library of kits can be built up over time.





- What is your situation?
- What is the purpose of the kit?
  (supplement a unit, organize materials, etc.)
- Who is it for? (grade level, school, etc.)
- How will it be used? (class only, teacher only, etc.)
- Where will it be stored? (closet, library, etc.)
- What are your resources?
  (funding, time, materials, personnel, etc.)
- What are your constraints? (as above.)
- How many copies are needed?
- Will it travel? (who will take it, pick it up, etc.)
- Who will repair, resupply, etc.?
- How will materials be obtained?
- How will it be tested or evaluated?
- How and when will it be revised?
  (time intervals, who will do it, etc.)
- How will it be shared?
  (in-house, city-wide, grade level, etc.)
- How will it be maintained? (who is responsible.)
- How will it be advertised?
  (budget, ways to get the word out)

Kit containers should be simple, but sturdy, and not difficult to transport or store. A ditto or xerox paper box may be sufficient if covered with Contact paper for strength. Shoe boxes, sweater boxes, storage boxes, giant cat litter pans, and plastic pails are all usable depending on the situation. The kit container is only limited by imagination and budget.

The components of the kit can vary depending on need, but some usual components may include the following.

- **Teacher's guide** - this should list materials, objectives, activities, references, sources, resources, and packing instructions. These are best placed in a notebook, but can be stored in a pocket attached to the container in a safe place.

- **Print materials** - may include books, magazines, pictures, newspapers, diagrams, postcards, articles, maps, or activity sheets.

- **Media materials** - may include lists of what is available and where to get it, or actual videos, audio cassettes, slides, etc. You may want to include blanks for students to create their own media.

- **Display boards** - of instructions, experiments, art work, or actual items such as animal bones, feathers, etc.

- **Hands-on items** - should be packaged and labeled separately for easy identification. Be careful about where and what you collect. Many items are protected by law, while others, such as nests, may still be being used.

- **Experiment tools** - such as hand lenses, microscopes, etc., should be packaged and labeled separately and include instructions for use.

Items should be labeled and laminated for protection. If laminating film is unavailable, clear contact paper or Clear Coat from an art supplier will work just as well. Label all items clearly and include instructions if necessary. Items may be obtained from science supply house catalogues, recycling centers, community businesses, and parent donations. Just let the public in your area know that you are interested in certain materials. Explore the school basement for old science kits that may be recycled.

Kit displays and graphics are important, but not difficult. Displays can be mounted on cardboard and hinged with clear packing tape so they stand alone. Foam trays, margerine containers, zip-loc plastic bags and transluscent folders can all be used for storing or displaying items. For mounting pictures, maps, etc., use long-term products such as 3M Spray Mount, Photo Mount, or Scotch Positionable Mounting Adhesive. A xerox machine and Copy-art books can be used for graphics. Pictures can be enlarged or reduced, and anything can be xeroxed - shells, bones, hands, etc. Labels can be created by enlisting the help of a peer or parent with a steady hand, or by using rub-off or peel-off letters. It may be wise to use a computer for the teacher's guide material so it can be stored and easily revised.

The activities used in the kit should be hands-on and require few materials. These are the roads students will travel toward discovery, so make them interesting and informative. Develop activities according to a designated format, like the one I use for SIE. Be sure to record the source of each activity for future reference. Include a range of activities that adapt well for varied grade levels, learning styles and teaching styles. Some should be hands-on inquiry-based, and some should be research-based so a variety of thinking skills are employed. There are many science activity books available as sources, or science magazines or old kits may also be used.

This is an overview of the kit making process. Individual needs and resources will dictate how thorough or elaborate a kit can be. Group development saves time and energy, and increases the idea pool. There are already museums or science centers in your area producing kits. Explore these or talk to museum staff for general or mechanical ideas. If you borrow from a commercial kit, indicate the source in your guide. Look at museum exhibits for ideas as well. Museums make big things little and little things big to enhance their displays - you can too!

The following lists provide some starting points for ideas, activities and supplies. Add your own discoveries to the list. Check out art supply dealers or catalogues to make price comparisons, and poll your school population for possible parental occupations that may be of help. The Yellow Pages and a phone can be invaluable for gathering information

and making decisions about supplies and materials. Check out the library for activity books and talk to teachers who seem to always have new ideas.

ACTIVITY BOOKS/MAGAZINES

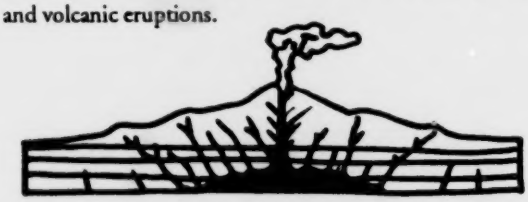
- *Exploratorium Science Snackbook.* The Exploratorium Teacher Institute, 1991.
- *Science Activities for Elementary Children* by Nelson and Lorbeer. Brown, 1972 and 1984. Both editions are useful and have different activities.
- *Science Activities, More Science Activities,* and *Still More Science Activities* from the Smithsonian Family Learning Project. Gallison books, 1987, 1988, 1989.
- *Simple Science Activities* by Ravensburger for Discovery Toys, 1988.
- *Creative Sciencing: Ideas and Activities for Teachers and Children* by DeVito and Krockover. Little, Brown, 1980.
- *Whole Cosmos Catalogue of Science Activities* by Hassard and Abruscato. Scott, Foresman, 1977, 1991.
- *Mudpies to Magnets* and *More Mudpies to Magnets* by Williams, et al. Gryphon House, 1987, 1990.
- *Nature With Children of All Ages* by Edith Sisson. Prentice-Hall, 1982.
- *Scienceworks, Foodworks,* and *Sportworks* from the Ontario Science Centre, 1988, 1987, 1989.
- *Science and Children, Science Scope* and the *Science Teacher* magazines published by the National Science Teachers Association, Washington, D.C.
- *Mr. Wizard's Supermarket Science.* Don Herbert, 1980.
- *Naturescope* published by the National Wildlife Federation, Washington, D.C. Subscriptions are no longer available, but individual back issues may still be purchased.
- *Thomas Edison Book of Easy and Incredible Experiments.* Thomas Alva Edison Foundation, 1988.
- *Creative Hands-on Science Cards and Activities.* Jerry DeBruin, 1990.

SCIENCE SUPPLY HOUSES

These are only a few of many companies supplying tools, models, supplies and books that can be used in kit making. Write for catalogues.

- Carolina Biological Supply , 2700 York Road Burlington, NC 27215 800-334-5551
- Edmund Scientific, E715 Edscorp Building Barrington, NJ 08007 609-573-6250
- Connecticut Valley Biological, 82 Valley Road PO Box 326 Southhampton, MA 01073 800-628-7748
- Delta Education, PO Box 915 Hudson, NH 03051 800-258-1302
- General Science Materials, 10123 Crosby Avenue Garden Grove, CA 92643 714-534-0985
- Museum Products Company, 84 Route 27 Mystic, CT 06355 800-395-5400
- Science Source, PO Box 727 Waldoboro, ME 04572 207-832-6344

Volcanoes and Earthquakes. Mary Elting. Simon and Schuster, 1991. Grades 3-8. This book provides a well illustrated and interesting account of famous earthquakes and volcanic eruptions.



Ice Ages: Past and Future. Jon Erickson. Tab, 1990. Grades 6-12. A report on the ice ages of the past and the inevitability of ice ages in the future. The book explains territorial and celestial causes as well as the effects of ice ages on the planet. The author concludes that the interglacial period is nearly over and that global warming, with man's help, may only hold off the next ice age a little longer.

Adventures with Rocks and Minerals: Geology Experiments for Young People. Lloyd Barrow. Enslow, 1991. Grades 3-12. This is an outstanding and accessible collection of experiments for readers interested in geology. The experiments are outlined in careful steps and include notes about what to be looking for and discussions of the relation of each experiment to scientific thought. A list of sources for collecting specimens and supplies, an index and an outline of safety procedures are included.

The Challenge of Mineral Resources. Robert Bates. Enslow, 1991. Grades 4 and up. An overview of the mining industry which explains how minerals are located, extracted, and produced into products. Bibliography, glossary and index.

Mineral Resources A-Z. Robert Bates. Enslow, 1991. Grades 4 and up. This book from the *Environment Reference* series is a companion volume to "The Challenge of Mineral Resources". It explains each mineral in more detail, and includes a list of agencies, institutes and interest groups concerned with geology and mining.

Water, Stones and Fossil Bones. Lind. NSTA, 1991. All ages. An activity book for all ages featuring a wide variety of activities.

Atlas of Earth Mysteries. Philip Whitfield. Rand McNally, 1990. Grades 5 and up. This volume outlines the progress made by science in explaining various geological and cosmological forces and their observable results. Includes a bibliography and index.

Why Do Volcanoes Erupt? Philip Whitfield. Viking, 1990. Grades K-5. Written in conjunction with the Natural History Museum, the text answers frequently asked questions about land formations, geology, fossils, earthquakes, volcanoes, weather, the atmosphere and astronomy. Includes a glossary and index.

Moving Continents: Our Changing Earth. Thomas Aylesworth. Enslow, 1990. Grades K-5. A clear account of how scientists have come to understand the forces which have changed the surface of the earth. Explains the theories of continental drift and plate tectonics concisely, and details their historical development. Discusses the theories from all sides.

Earthquakes: Looking for Answers. Margaret Poynter. Enslow, 1990. Grades K-5. Includes a history of how we have learned about earthquakes.

Exploring Soil and Rocks. Ed Catherall. Steck-Vaughn, 1990. Grades 4-6. This book will familiarize young readers with the topic and includes experiments (needing adult supervision) which enhance the ideas. Includes: acidity, soil types, organic and inorganic soils, fossil fuels, history of earth, plate movement and volcanoes and earthquakes.

Crystal and Gem. R. R. Harding. Knopf, 1991. Grades 3-12. Explains the formation of crystals in nature, and

outlines identification properties and procedures, growing crystals and the uses of crystals in medicines, technology and communication. Discusses some lore and legends and collecting techniques.

Earthquakes. National Science Teachers Association and FEMA. NSTA, 1988. Grades K-6. A comprehensive curriculum on earthquakes featuring a scope and sequence, background, activities and reproducibles.

Volcano. Lionel Bender. Watts, 1988. Grades 3-8. This is one of the *Story of Earth* series. It accurately describes the ten stages in a typical volcanic eruption. Information on how volcanoes affect people and animals is also included.

The Magic School Bus Inside the Earth. Joanna Cole. Scholastic, 1987. Grades 2-6. One of the *Magic School Bus* series, this book takes Miss Frizzles class on a trip through the earth's core to discover the wonder of geology. Packed with information, the book invites repeated readings.

How to Dig a Hole to the Other Side of the World. Faith McNulty. HaperCollins, 1979. An informative tour through the earth's core as a child attempts to reach China by the quickest route.

Start Collecting Rocks and Minerals. LeeAnn Scrogi. Running Press, 1989. Grades 4-8. The book comes with its own rock collection to encourage interest in geology. The formation, types, qualities, identification, and location of rocks and minerals are discussed. Glossary and bibliography.

Icebergs and Glaciers. Seymour Simon. Morrow, 1987. Grades 2-5. Provides a view of glaciers and their frozen offspring, icebergs. The scientific efforts to understand these phenomena are discussed.

Rocks and Minerals. David Lambert. Watts, 1986. Grades 2 and up. Explores the formation of rocks and minerals and discusses varieties and collecting methods. A glossary, index and pronounciation key are included.

Recent Revolutions in Geology. Rossbacher. Watts, 1986. Grade 5-12. The author surveys recent theories such as plate tectonics, mass extinction, and extraterrestrial geology. Includes a glossary and index.

Earth Science Library Series. Martin Bramwell. Watts, 1986. Grades 5 and up. The books in the series, *Volcanoes and Earthquakes, Mountains, Rivers and Lakes,* and *Glaciers and Ice Caps,* present overviews of "earth-moving" processes. Each examines both past and present scientific techniques and discoveries.

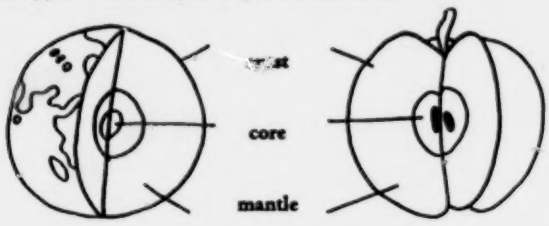
Pompeii: Buried Alive! Kunhardt. Random House, 1987. Grades K-3. Weaves history and science together for young readers in explaining the eruption of Mt. Vesuvius.

Stone, Clay, Glass: How Building Materials Are Found and Used. Bates. Enslow, 1987. Grades 5-8. Readers learn where and how nonmetallic materials are found and how they have been used since ancient times. Includes a bibliography, glossary and index for research.

Digging Deeper: Investigations Into Rocks, Shocks, Quakes, and Other Earthly Matters. Markle. Lothrop, 1987. Grades 3 and up. Introduces current examples of geologic processes. Although the book is five years old, the explanations are concise and relevant. Glossary and index.

1001 Questions Answered About Earth Science. Richard Pearl. Dodd, Mead, 1966. Grades 4 and up. A good background reader for the science of geology.

The Earth is constantly on the move. Although the motion is constant, events happen so slowly that they are not noticed over a lifetime. The Earth is divided into three layers: the thin **outer crust,** the thicker **mantle,** and a molten **core.** How they interact and what they are made of is still being debated. The earth is similar in appearance to an apple. Cut one open to get a better look

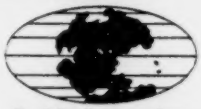


Geologists can study the crust or **lithosphere** first hand, as can even the youngest student. It is a thin rigid rocky skin. The continental crest is made up mostly of light-colored granitic rocks composed mostly of the elements silicon and aluminum. The oceanic crust is of denser basaltic rocks composed mostly of the elements silicon and magnesium. Because of its lighter weight the continental crust floats higher on the mantle than the basaltic crust.

The zone beneath the lithosphere is called the mantle. Our knowledge of the mantle is based on the behavior of seismic (earthquake) waves whose speed is changed when the density of the material changes. We have no certain knowledge of its composition. However, seismic wave studies indicate that the upper layer of the mantle is a hot and "weak" solid, and that this outer layer does flow very slowly. The name **asthenosphere** (weak) is given to this top layer.

The core, deep within the earth, forms the largest part of Earth's mass. Seismic waves indicate it is twice as dense as the mantle, and that the outer core is molten while the inner core is solid. This greater density leads geologists to postulate that the core is composed of iron and nickel compounds.

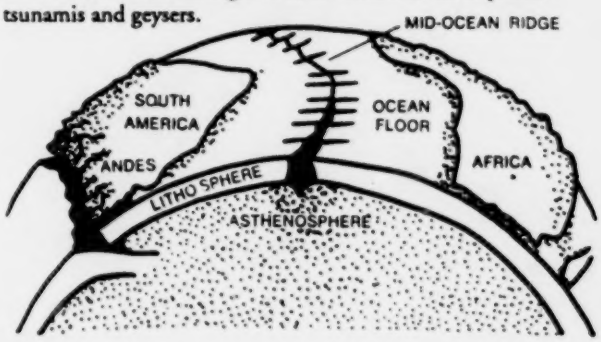
Most geologists think that powerful **convection currents** in the mantle, driven by heat from the core and radioactive decay, are the forces behind the changes in the crust. The **plate tectonics theory** proposes that the lithosphere is divided into about 12 enormous plates and five or more small plates that "float" on top of the athenosphere. Radioactive elements within the earth release heat that drives convection currents inside the earth; these currents ferry the plates across the surface of the athenosphere at the rate of a few centimeters a year. The plates can be thousands of miles across, and move relative to each other carrying the continents and ocean basins with them. Most mountain building, and volcanic/earthquake activity takes place along the margins of the plates. Another theory proposes that in some rift areas (deep trenches such as the Mid-Atlantic rift) magma is rising between the plates to form new crust. This spreading ocean floor moves the continents apart while in other areas, old crust is being destroyed. When two plates crash, mountain ranges may be pushed up. When two plates slide by each other, as in the San Andreas Fault, the resulting friction may cause earthquakes. In some places, narrow plumes of hot material rise up from the mantle creating a "hot spot". As the plate moves over the "hot spot",the extra heat melts some of the mantle rock which then makes its way up through the plate to form a volcano. The continuing movement of the plate over the hot spot results in a line of volcanoes such as the Pacific Ring of Fire.



Earth land masses about 200,000,000 years ago.

Earth land masses about 50,000,000 years into the future.

Subduction occurs when continental and oceanic plates collide. The heavier oceanic plate bends down and slides under the other plate. The pressure pushes up mountains, such as the Andes, along the margin. The lower plate begins to heat up in the mantle, and this **magma** (melted rock) fuels volcanoes in the newly formed mountains. There are other swift, violent changes such as volcanoes, earthquakes, tsunamis and geysers.



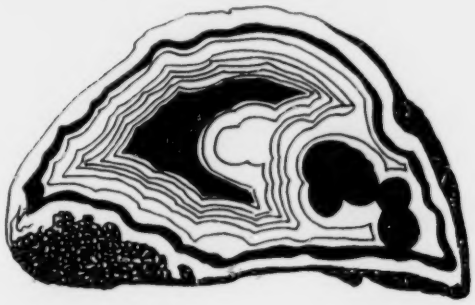
What a **volcano** looks like, and what comes out of it depends on where and how it formed. In the rifts where plates move apart, a thinner lava called basalt oozes out of undersea volcanoes. Where crusts are colliding, lava is thicker and often creates violent eruptions as trapped gases explode. **Earthquakes** can happen anywhere, but most occur along plate margins. The earthquakes occuring where plates slip past one another are the most violent and destructive. Stresses in the crust cause sudden slippage on fault surfaces. Shock waves spreading out from this focal point cause the earth to "quake". The **epicenter**, directly above the slip, has the most intense shock waves.

Tsunamis are giant ocean waves that start when a sudden motion of the Earth jolts and displaces water. Most tsunamis occur in the Pacific Ocean. A wave's height and speed are affected by the depth of water and shape of the ocean floor. A tsunami may be 3 feet (90cm) in the middle of the ocean, but over 100 feet (30m) by the time it reaches shore. **Geysers** are formed when groundwater circulating deep underground is heated by hot rocks underlain by molten magma. This groundwater is changed to steam, and the geyser will "blow" when there is sufficient pressure. Some geysers may gush for a few minutes and others will go on for several minutes. The most famous geysers are found in New Zealand, Iceland and Yellowstone National Park, Wyoming.

MINERALS AND ROCKS

There are about 2000 **minerals** in the world, but 10-20 of these make up 90% of the crust. All minerals are made up of one or more chemical elements, and to be called a mineral, must also fit the following criteria:

- **Inorganic** - not formed from the remains of living things.
- **Occur naturally** - gold, silver, carbon, sulphur, quartz, calcite and felspar are examples of minerals.
- **The molecules possess a specific chemical make-up** - for example, calcite is calcium carbonate, or one calcium atom, one carbon atom and three oxygen atoms.
- **These atoms are bonded together in specific repeating patterns** to form a molecule of the mineral. This pattern is reflected in the characteristic crystal shape (may be apparent only on a microscopic level) demonstrated by some minerals. Crystal size depends on how long it is growing, how much of the needed elements is available, and how much space is available.

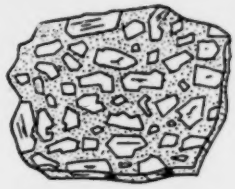


Minerals may look similar as quartz and calcite do, but a specific mineral may look very different in its individual forms. These forms may be pink, clear, milky, blue, or lavender depending on whether traces of nickel, iron, or other chemical impurities are present. Geologists therefore consider **color, luster** (light reflection), **cleavage** (how it splits), **crystal shape, hardness, specific gravity, magnetic properties** and its **ability to glow** under ultraviolet light when identifying a mineral.

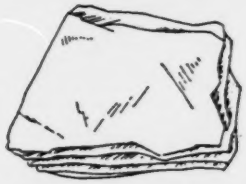
Minerals that are unusually beautiful, rare and durable are called **gemstones**. Rubies and sapphires are forms of the mineral **corundum**; emeralds, a variety of **beryl**; diamonds a variety of **carbon**; and amethysts a variety of **quartz**. We use many minerals in daily life: graphite for pencils, felspar for cleaning powders, salt for seasoning, metals and gemstones for jewelry, quartz sand for glass, metal-oxides for paint, aluminum for cans and foil, etc.

Rocks are substances made up of one or more minerals. Rocks are the building blocks of the earth and make up the crust. A rock may not always contain the same proportions of its minerals, and the size of its crystals may vary. Granite, the most common rock in New England, is made up of quartz, mica, feldspar, and sometimes hornblende. The rock limestone is made of calcite mostly. Rocks are formed in one of three ways.

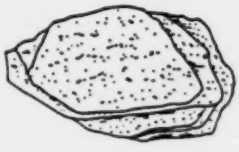
- **Igneous rocks** - form when magma cools and hardens. Granite and other grainy-looking igneous rocks are formed underground; basalts are formed above or close to the surface where the magma cools before crystals can grow large enough to be visible to the naked eye. Obsidian cools before any crystalline structure can be formed at all presenting us with an amorphous solid similar to glass.



- **Sedimentary rocks** - are layered. Loose sediments wash into rivers or oceans and settle on the bottom. As the sediments pile up over time, pressure increases. The layers are compacted and sometimes cemented together by other chemicals dissolved in water percolating between the layers of granular material. Sometimes the heat causes water evaporation, and the minerals contained in the rocks crystalize. Halite and some limestone forms this way. Coal and chalk form from organic material such as shells, skeletons and plants included in the sediments.



- **Metamorphic rocks** - are formed when heat and pressure change the mineral structure of igneous and sedimentary rocks. For example, calcium carbonate from limestone recrystallizes to become marble, and heat and pressure on shale turns it into slate.



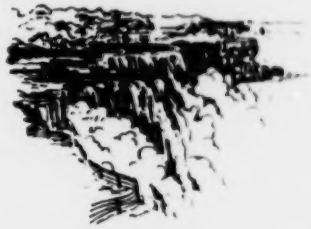
Some of the minerals we use are **metals**. Some metals can **conduct heat and electricity**, have a **natural shine**, are **malleable** and have a **high density**. Not all metals have all of these characteristics, but every metal has some combination of metallic traits. Most metals are not very abundant in any one place, and usually occur as tiny flakes within rocks. If a metal does occur in any abundance in one area, it is called an **ore** and is mined. Then it is **refined**, or extracted from the rock. Mining can also cause massive damage to the snvironment. Care must be taken to minimize damage.

WEAR AWAY FORCES

Erosionary processes continually wear away all rock types forming new sediments and eventually rocks. Each volcanic eruption forms new rocks. Studying rocks and the way they recycle helps scientists learn more about how the Earth changes. There are forces constantly at work reshaping the landscape.

At or near the surface of the earth's crust, rocks are decomposed by the process called **weathering**. Weathering breaks up rocks readying them for removal by erosion.

Running or moving water is the most effective land-shaping agent. The physical force of currents and waves breaks up and wears away rock.



Temperature changes shrink and expand rocks until the outer layers flake off. Freezing water expand in cracks and acts as a wedge to fracture apart rocks.

Chemical action decomposes the mineral structure of rocks and water carrying dissolved gases. Both naturally occurring carbon dioxide and oxygen and the acid-forming air pollutants such as sulfur dioxide and nitrites are present in the water percolating through the rocks. The exposed surfaces of iron-bearing rocks soon rust to an organge-red color. Statues and gravestones of marble lose their features to the chemical action of "acid rain".

Organic action such as the growth of plant roots creates pressures as they push into cracks and continue to enlarge until the rock cracks. Worms tunnel through rocks. Burrowing animals beak up soil, so water can carry it away.

Winds carrying sand buffet and shape rocks. This effect is especially prominent in the desert regions and adds to the already present sand and silt.

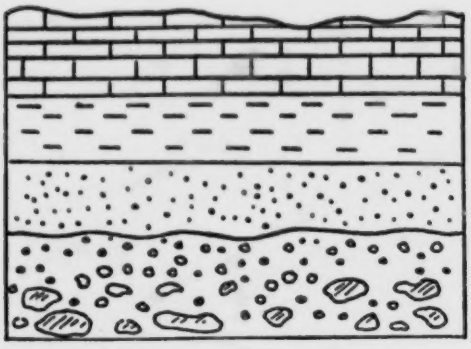
BUILD UP FORCES

Most building up of the Earth is the result of plate tectonics. Mountains, faults and volcanoes are formed as rocks are pushed up, warped, folded, fractured and/or extruded from the mantle's melted rock. Smaller-scale building can be done by water, ice and wind. The sediments carried by erosion create new landforms in an ongoing process.

- **Deposition** - most of the sediment dumped by running water ends up in the lakes or oceans forming deltas. Deposition forms beaches and dunes.

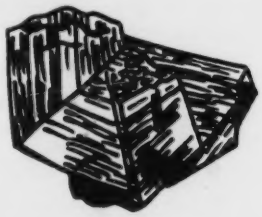
- **Alluvial fans** - sediments dumped along rivers and streams form flood plains, and when dumped at the retreating edges of glaciers, form moraines (fields of sediments) and kame terraces (ridges of sediments).

- **Layering** - layers of sedimentary rock form from pressure on the sediments. These layers can contain fossils that indicate what the environment was like in the time the layer was laid down. The oldest layers are at the bottom except when upheavals of the earth turn rock layers up on end or invert them.



- **People** also reshape the land. Erosion is speeded by clearing land, lumbering and strip mining. River courses are changed by dams and channeling and mountains are torn down when blasted away for highways. These activities accentuate the natural processes of weathering, erosion and deposition.

After students have investigated geologic phenomena and the properties of rocks and minerals, mineral indentification tests may be performed. Can students distinguish between these rock mysteries, chosen because the rocks are similar? Use the tests in the activity section to find out which is which.



Caution: Infallible identification is not always possible by these simple tests. Be certain that students understand that professional geologists and mineralogists start with these simple tests, but often must go to laboratory equipment to perform more precise tests in order to be certain in the identification of a mineral.

- calcite/quartz
- marble/quartz
- obsidian/biotite mica/anthracite
- chalcopyrite/pyrite
- sandstone/limestone
- chalk/limestone
- graphite/galena
- slate/shale
- hematite/magnetite
- slate/hematite

Samples may be obtained from science supply houses, local science centers, museum stores, or from quarries, construction sites, monument manufacturers, etc. Only one or two samples of each is needed, as this should be a long term study. Obtain some field guides to rocks and minerals for help with identification. There are many excellent, inexpensive field guides that can be used on a variety of levels.

Earth: The Inside Story and Earth Through Space and Time are available for the Apple II family. Each package, geared for grades 4-6, offers a colorful set of graphics and questions about geology. The programs offer an option for games to go along with each question. Two disks, teacher's guide and ideas are included.
Educational Activities, Inc.
P.O. Box 392
Freeport, NY 11520

Mineral Tests is a program for the Apple II family geared for grades 4-6. The program helps students learn about the properties of minerals. Two disks, teacher's guide and ideas are included.
Focus Media, Inc.
839 Stewart Avenue
P.O. Box 865
Garden City, NY 11530

Master Mapper contains four disks, a teacher's guide and five reproducible masters. Geared for grades 3-7, it can be used with the Apple series. Lessons on compass directions introduce the concept of latitude.
Imperial Learning Corporation
P.O. Box 548
Kankakee, IL 60901

The Changing Earth is a program for grades 3-6. Students become members of a geologic survey team which must drill through the earth's layers. They assume the status of geophysicist, drilling engineer, or geologist to perform tests. All scientific skills are applied during the simulation. For the Apple 48K, it includes disk and back-up, teacher's lesson plans, and on-screen progress management systems.

Mountains and Crustal Movement allows students to re-create site formations at U.S. National Parks, to gain concrete understanding of the geomorphic processes. For the Apple 128K, the program includes lesson plans, a guide, a back-up disk, and on-screen management systems for grades 4-8.

Dating and Geologic Time, for the Apple 128K, allows students in grades 4-8 to become geologists and date and identify a variety of rock and mineral samples. Students learn about rock formation and simulate scientific tests. Includes a back-up disk and lesson ideas, as well as on-screen management.
The above three computer programs are available from:
William K. Bradford Publishing Co.
310 School Street
Acton, MA 01720
(800) 421-2009

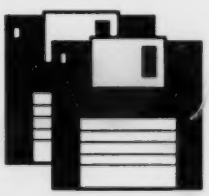
Geology is a program for Apple II's and IBM PC. Geared for grades 3-6, the program features three simulations. *Rock and the Earth's Surface Features* simulates rock types, land forms, and how land changes; *Climate and Weather* simulates the effects of water, wind and temperature on rock and soil; *Rivers and How They Are Shaped* introduces river formations and the processes of erosion and soil deposition; and *Changing Features* provides a culmination of all concepts.

BGW **Rocks and Minerals** is a program geared for grades 3-6 which can be used on the Apple series. It introduces students to geology basics, simulates a volcanic eruption, and discusses the formation of all types of rocks and crystals. Charts are included which identify basic rock features. All student work may be printed at the end of each section.

Murphy's Minerals allows students to mine for minerals and gems that will bring the best prices at Murphy's Mineral Shop. Samples can be tested on-screen. The program includes over 100 minerals to be tested. Geared for grades 3-6, the program can be used on the Apple 128K.

Simulations in Earth Science is a series of four programs using simulations, animated graphics, data collection routines, tutorials and more to allow students to investigate basic concepts. Includes a back-up disk and worksheets for grades 3-6, and can be used with the Apple II family. The programs include: *Volcanoes; Earthquakes; Weather Instruments;* and *Clouds.*

The above four computer programs are available from:
Queue, Inc.
338 Commerce Drive
Fairfield, CT 06430
(800) 232-2224



Magic School Bus Inside the Earth by Joanna Cole is a featured story on Reading Rainbow (#66). It includes the story and a visit to active Hawaiin volcanoes, along with plenty of background information.
Great Plains National TV
PO Box 80669
Lincoln, NE 68501
(800) 228-1630

Four filmstrip/cassette kits are geared for grades 2-6 and include teacher information. **Exploring the Earth Around Us** (#CO3242) explores the formation processes of mountains, plains, deserts, rivers and oceans. **What We Get From the Earth** (#CO4418) demonstrates the use of geological resources. **Weathering and Erosion** (#CO4634) illustrates the processes that change the earth's surface. **Our Ever Changing Earth** (#CO3730) examines plate tectonics and causes of volcanoes and earthquakes. All of the packages are available from:
National Geographic Educational Services
P.O. Box 98019
Washington, D.C. 20036
(800) 368-2728

Earth's Dynamic Crust/Shaping of a Continent is a plastic chart featuring geological and plate tectonics information and pictures. Order #C20005 at a cost of $10.90.
National Geographic Educational Services
P.O. Box 98019
Washington, D.C. 20036
(800) 368-2728

The **Protect Our Planet Calendar** offers simple suggestions for making the world a safer, healthier place. A copy costs $8.95 plus $2.50 postage and handling.
Running Press
125 S. 22nd Street
Philadelphia, PA 19103
(800) 345-5359

Field Guides Made Easy is a publication that differentiates field guides and highlights how to distinguish identifying characteristics. Copies are available for $2.50.
Cornell University Resource Center
7 BTP
Ithica, NY 14850

The **Favorite Wildflowers Coloring Book** presents detailed drawings of familiar blooms. Captions describe each flower and provide botanical and common names. The cost is $5.40 including postage. New York residents should add sales tax.
Dover Publications, Inc.
31 E. 2nd Street
Mineola, NY 11501

Elementary School Science for the 90's is a book which explains how to set up, organize and teach a school science program. It is available for $13.95 (ask for stock no. 611-90110).
Association for Supervision and Curriculum Development
1250 N. Pitt Street
Alexandria, VA 22314-1403

Oceanography for Landlocked Classrooms presents experiments students can do anywhere to gain knowledge of the sea, its plants and its creatures. The cost is $17 including postage and handling.
National Association of Biology Teachers
11250 Roger Bacon Drive #19
Reston, VA 22090

The following companies provide **educational science games** to help students absorb important messages about concepts and the environment. Often royalties from game sales are donated to environmental or wildlife agencies. Write or call for a current catalogue.
Animal Town Game Company
P.O. Box 485
Healdsburg, CA 95448
(800) 445-8642

Aristoplay
(800) 634-7738

Backos Games
(800) 544-6299

Battat Games
Developing Child
19956 Ventura Blvd.
Woodland Hills, CA 91364
(800) 426-4777

European Toy Collection
(219) 763-3234

Family Games
P.O. Box 97, Snowdon
Montreal, Quebec H3X 3T3
(514) 485-1834

Safari Games
(800) 554-5414

All About Beach Cleanups: A Helpful Guide to Planning a Beach Cleanup is a comprehensive outline for organizing a community cleanup effort. Cost is $1.
Center for Marine Conservation
1725 DeSales Street, NW
Washington, D.C. 20036

D. R. Boren offers **rock and mineral samples** for classroom use. Specimens range from $.50 to $1. Write for a list or make specific requests.
D. R. Boren
Box 1018
Stephenville, TX 76401

Water in Your Hands is an educational booklet on water resources. Single copies are $.75. The instructor's guide costs $2. Quantity discounts are available.
Soil and Water Conservation Society
7515 NE Ankeny Road
Ankeny, IA 50021-9764

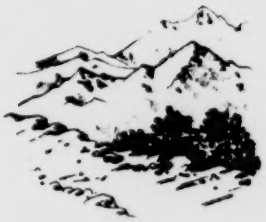
A full color **wetlands poster** featuring 43 plants and animals is available for $3.
Department of Conservation
Division of Natural Heritage
524 S 2nd Street
Springfield, IL 62701-1787

A Sedimentary Geologist's Guide to Helping K-12 Earth Science Teachers: Hints, Ideas, Activities and Resources is a guide for curriculum and planning. The cost is $6.75 including postage.
Society for Exploration Petrology and Minerology
PO Box 4756
Tulsa, OK 74159-0756

Adventures in Geology is a K-8 curriculum featuring inquiry-based activities. It is available for $7. Ask for a free single copy of **43 Earth Science Resources References.** Earth Science for the 21st Century: A Planning Guide aids in planning an earth science curriculum for K-12. How to Collect Mountains describes types of mountains and activities.
American Geological Institute
4220 King Street
Alexandria, VA 22302-1507

You Are an Environment is an educational stretegy for developing positive attitudes about the environment. Including classroom activities, the program costs $7. Limited supplies available.
North American Association for Environmental Education
Brukner Nature Center
5995 Horseshoe Bend Road
Troy, OH 45373

The World Peace University Field Guide to Connecting with Nature: Creating Moments That Let Earth Teach is available for $10.95.
World Peace University
PO Box 10869
Eugene, OR 97440



Dinosaurs and Power Plants is a brochure telling the story of mining for coal, gas and oil, that includes a teacher's guide with reproducible graphics. Posters and other items are also available.
Office of Communication
Office of Fossil Energy
U.S. Dept. of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585

Three science units for grades 2-6 integrate math, science, art and literature using hands-on interactive activities. **Birds of Prey, Sounds,and Sharks** cost $8.95 per kit including postage. All three kits are available for $21.95. Each kit includes a teacher's guide and audiotape. Also available is **Focus on Science Education**, a new quarterly newsletter filled with tips and resources. Each issue includes a free activity. The cost is $5 per year. One free copy may be requested.
California Academy of Sciences
Golden Gate Park
San Francisco, CA 94118

Science Brainstretchers: Creative Problem-Solving Activities in Science is geared for students in grades 4-8. Critical thinking activities are provided in earth, life and space science.
Good Year Books
Scott Foresman and Co.
1900 E. Lake Avenue
Glenview, IL 60025

Hanging on to the Wetlands is a curriculum of 36 activities that integrate wetland studies with all sciences and other curriculum areas. The cost of the package is $28 including postage. Make checks payable to
Irwin L. Slesnick.
Dr. Slesnick
Biology Department
Western Washington University
Bellingham, WA 98225

Teacher Resource Book on Earth Science commemorates the 20th anniversary of the Apollo 11 Moon landing. It includes history of the Apollo project, information on the Moon, and activities for K-12 students. Cost is $10.
Jack Holbrook
International Council of Associations for Science Education
Dept. of Curriculum Studies
University of Hong Kong
Hong Kong, China

Directions for making a small paper model that shows the fault motion at depth of Loma Prieta earthquake (October 17, 1989) is available for $1.50. Request # OF89-640-A. Copies are also available on disk for the Macintosh (#OF89-640-B) and cost $4. Also request the pamphlet **Lessons Learned from the Loma Prieta Earthquake** (Circular 1045) free.
USGS Book and Report Sales
Box 25425
Denver, CO 80225

A bibliography of teaching materials related to earthquakes and earthquake safety is available free.
Kathryn Ross
National Center for Earthquake Engineering Rsearch
State University of New York
104 Red Jacket Quadrangle
Buffalo, New York 14261

The **"Wee" Sprouts salad kit** teaches five days of science, nutrition, photosynthesis, responsibility and sharing. Experiments vary, but students end up growing a sald they can eat. The kit includes a story book, shatterproof growing jar, seed mixture, and daily teacher instructions. Kits are reusable and replacement seeds cost $.30. Each kit costs $1.55 including postage. A minimum order is 12 kits.
"Wee" Share International
PO Box 1028
Pagosa Springs, CO 81147
(800) U-SHARED

Knowledge Unlimited offers several posters and series for teachers.

- The Planets - nine posters; teacher's guide; $24.95, #7012P.
- Solar System Exploration - glow-in-the-dark poster; $12.95, #SSE92.
- Map of the Universe - poster with guide; $12.95, #SSE91.
- Freshwater Tropical Fishes - poster; $12, #1930P.
- North American Eagles, Hawks and Falcons - poster; $12, #NDP4.
- North American Dolphins and Whales - poster; $12, #NDP1.

- Map of the Moon - poster; $12, #225OP.
- The Big Cats - poster; $12, #214OP.
- Butterflies - poster; $12, #218OP.

Add 8% shipping and handling (minimum $3.50) with all orders.
Knowledge Unlimited
Box 52, Dept. C91-1
Madison, WI 53701-0052
(800) 356-2303

The following newsletters on geoscience are available. Together they offer an interesting geological picture of the United States. Contact your state geologist to get information on your state or contact:

National Center for Earth Science Education
Attn. Geological Department
420 King Street
Alexandria, VA 22302-1507

Arizona Geology offers two issues annually.
Arizona Geological Survey
845 N. Park Avenue, Suite 100
Tucson, AR 85719

Minnesota Geological Survey offers two issues annually.
Minnesota Geological Survey
University of Minnesota
2642 University Ave.
St. Paul, MN 55114-1057

Ohio Geology Newsletter publishes four issues annually.
Ohio Dept. of Natural Resources
Division of Geological Survey
Fountain Square, Bldg. B
Columbus, OH 43224

Survey Notes offers four issues annually.
Utah Geological and Mineral Survey
Salt Lake City, UT 84108-1280

Science International offers four issues annually.
International Council of Scientific Unions
Secretariat
51 bd de Montmorency
Paris, 5016, Franc:

Washington Geologic Newsletter is published four times annually.
Dept. of Natural Resources
Division of Geology and Earth Resources
Mail Stop PY-12
Olympia, WA 98504

Career Profiles is a booklet describing careers available in earth sciences including the careers of 20 women geologists. One copy is free from:
Association for Women Geoscientists
Geology Department
Macalaster College
1600 Grand Avenue
St. Paul, MN 55105-1899

Classroom Archaeology is a teacher's manual for grades K-12 featuring both individual and group activities.
Division of Archaeology
Office of Cultural Development
State of Louisiana
PO Box 44247
Baton Rouge, LA 70804

Aviation and Space Education Teacher Resource Guide features 27 pages of resources and activities.
Texas Dept. of Aviation
PO Box 12607
Austin, TX 78711-2607

A sample copy of **Issues in Science and Technology**, a quarterly journal, is available.
National Academy of Sciences
2102 Constitution Avenue, NW
Washington, D.C. 20077-5576

A copy of the **endangered species list** and other items are available. Write for a catalogue and price list.
Defenders of Wildlife
1244 19th Street, NW
Washington, D.C. 20036

The **U.S. Geological Survey** provides free teacher materials. Requests must specify grade level and be on school stationery.
U.S. Geological Survey
Geologic Inquiries Group
907 National Center
Reston, VA 22092

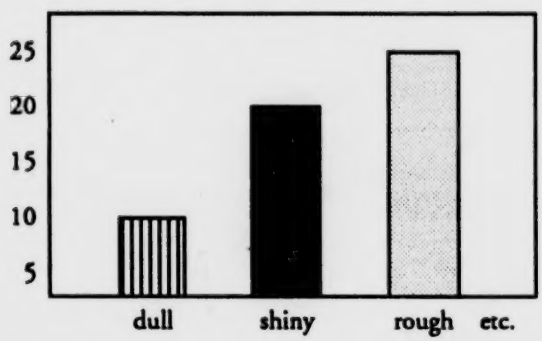
SECRETS OF THE STONES

Objective:
Students will collect, observe, describe, test and sort rocks. Granite can be collected with permission at monument companies or excavation sites. DO NOT ENTER SITES UNSUPERVISED.

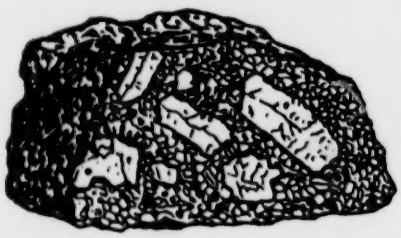
Materials:
- collected granite samples
- student collected rock samples
- hand lenses
- chalk and board
- colored pencils or markers
- paper

Procedure:
1. Have students bring a variety of rocks to class. Spread out and examine the samples. Students should each select one sample for further study. List words that describe the samples (sparkly, jagged, smooth, etc.). Then sort all collected samples under two of the categories listed: smooth/rough, shiny/dull, etc.

2. Graph the rock characteristics as shown. This activity provides some raw data for the students to begin using. Using the graph, make some hypotheses about the rocks in the collection area - are there more shiny samples? more dull?, etc.



3. Students should then closely examine the samples for color, size and shape. Each student should sketch his or her sample striving for detail. Because rocks consist of mineral combinations, some samples may be later identified by the minerals they contain (using Mineral Tests activity).



4. The minerals feldspar, quartz and mica or hornblende are found in granite. Pass out granite samples and have the students closely observe them. **Feldspar** looks gray, white, or pink. The clear, glassy material is **quartz**, and the dark speckles are **mica** or **hornblende**.

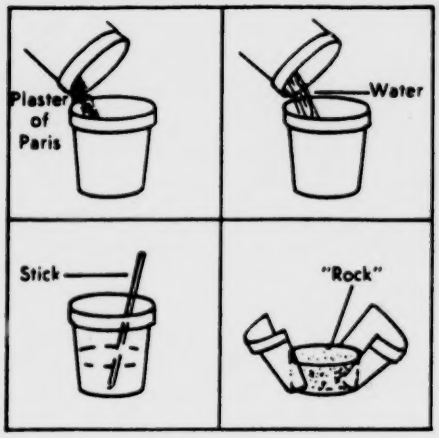
5. Students should sketch the granite and then compare the two sketches. Granite is made up of some minerals, but not in the same proportions. Can students identify any minerals in their collected samples? Discuss the comparative results of the scientific sketches by listing colors observed, the color most observed, the rock's luster (shiny, metallic, glassy, dull), and the general size, shape and hardness.

Adapted from *NATURESCOPE*, the National Wildlife Federation, Vol. 3, No. 2.

GO AHEAD, MAKE MY CLAY

Objective:

Students will explore ways to make artificial rocks. Rocks are **carbonates** (carbon-based) or **silicates** (silicon-based). Those that bubble when vinegar is dropped on them are carbonates.



Materials:

- paper cups
- plaster of Paris
- Portland cement
- plasterer's lime
- stick
- water
- scissors or knife
- rock samples collected by students

Procedure:

1. Pour about 1/2" of plaster of Paris in a cup, adding a little water. Stir gently. In a second cup, pour the same amount of Portland cement, adding a little water and stirring gently. Repeat the same steps for the plasterer's lime.

2. Cut the paper cups down the side and peel them away after the "rocks" have hardened.

3. Examine the "rock" samples. These are artificial rocks but the formation process is similar to nature's.

4. Perform the vinegar test on each sample. Which are carbonates and which are silicates? Repeat the test using rock samples collected by students.

Adapted from *SCIENCE ACTIVITIES FOR ELEMENTARY CHILDREN* by Nelson and Lorbeer.
Little Brown, 1984.

SEDIMENTARY, MY DEAR WATSON

Objective:

Students will explore the process of **sedimentation** - layers of solid matter being laid down over time. Pressure and weight eventually form sedimentary rock.

Materials:

- plastic jar with lid
- pebbles, sand and dirt
- water
- pictures or samples of sedimentary rock

Procedure:

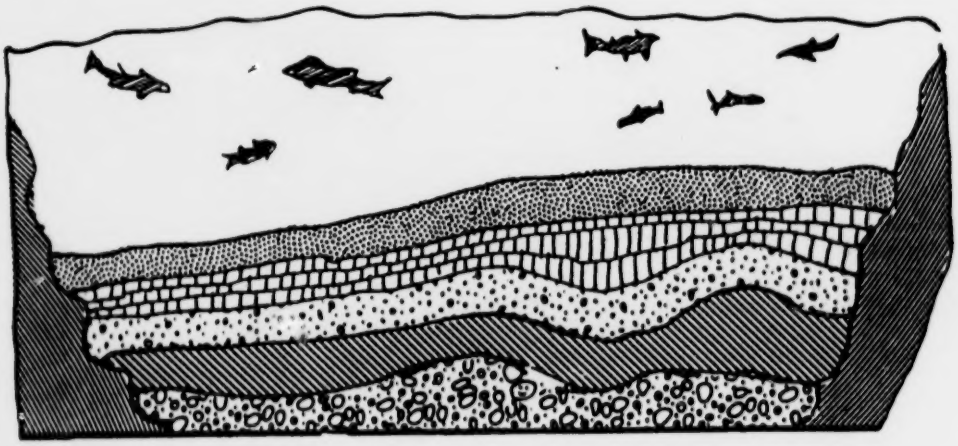
1. Place the pebbles, sand and dirt in the jar. Slowly add water until the jar is almost full. Put the lid on tightly. Shake the jar until the contents are well mixed.

2. Observe the jar's contents after every 5 minutes. After 30 minutes, defined layers of solids should be visible. Observe again after 24 hours. Leave the jar to see how long it takes for the water to be clear again.

3. Which layer formed first? The pebbles should be first to settle, as heaviest layers settle first. The soil, being the lightest layer, should have settled last. In moving water, the soil would also have been carried the farthest.

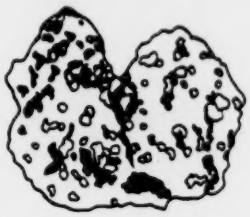
4. Observe pictures or samples of layered rock. Hypothesize about layer contents - how would they have been laid down? what characteristics of each layer can be observed?

Adapted from the *MUSEUM OF SCIENCE* Rocks and Minerals Kit.



TOO HOT TO HANDLE

Objective:
Students will explore the formation of **igneous rocks.** Igneous rocks are formed when melted rock (**magma**) solidifies.



Materials:
- white glue
- liquid starch
- plastic container
- waxed paper
- pictures of liquid magma

Procedure:

1. Prepare magma by mixing 2 parts white glue and 1 part liquid starch in the plastic container. Do not let mixture touch carpet. After washing hands, form magma balls. If the mixture is too sticky add more starch.

2. Students should briefly handle the "magma" and describe its properties (smooth, squishy, etc.) Compare the properties to pictures of magma.

3. Have students hold the magma ball in one hand, make a fist, and squeeze. What happens? The mix pushes up through the cracks in the fingers. Volcanoes are openings in the earth's crust and students' hands are acting as volcanoes.

4. Shape the magma into rock shapes and place the "rocks" on waxed paper. Hypothesize about what will happen over night. Examine the rocks the next day. The rocks will have hardened just as magma does when cooled. It will take a few days for the rocks to fully harden.

Adapted from *INSTRUCTOR* February, 1992.

SHAKE IT UP

Objective:
Students will explore **water erosion** on rocks by speeding up the process.

Materials:
- plastic quart jar with tight lid
- water
- broken chunks of red clay bricks
- piece of cotton cloth

Procedure:

1. Fill the jar 1/3 full of brick pieces. Completely fill the jar with water and tightly seal the lid.

2. Every time the class leaves or enters the room have a student vigorously shake the jar for 2-3 minutes.

3. Examine the brick chunks after a week. Filter the chunks through the cloth. They will have broken into smaller pieces as they were churned back and forth in the water and bumped into other chunks. Running water in rivers or ocean waves has the same effect on the rocks transported by them. As the rocks strike each other, they are broken into smaller pieces and rounded smooth.

Adapted from the *MUSEUM OF SCIENCE* Rocks and Minerals Kit.

ON THE ROCKS

Objective:
Students will explore the power of ice in changing the face of the earth. Evidence of glacial restructuring, both past and present, is observed everywhere.

Materials:
- plaster of Paris
- water
- small balloon
- bottom halves of two, pint milk cartons
- freezer; ice cubes
- sand
- several flat pieces of shale or limestone
- two paper towels
- ice cube tray

Procedure:
1. Explore what happens when water freezes and melts in cycle. Fill the balloon half full of water until it is ping-pong ball size. Tie a knot in the end.

2. Mix water with plaster until the mixture is thick as yogurt. Pour half of the plaster in one milk carton and the other half in the other carton.

3. Push the balloon down into the plaster in one carton until it is about 1/4" below the surface. Hold the balloon there until the plaster sets enough so the balloon doesn't rise.

4. Let plaster harden for about an hour. Then put both milk cartons in the freezer overnight. Remove the cartons the next day and observe the changes. The plaster containing the balloon should have cracked as the water inside froze and expanded. When water seeps into cracks in the rocks and freezes, it can eventually break the rocks apart.

5. Next, explore ice movement. Mix several teaspoons of sand with water and pour the mixture into ice cube trays. Freeze these. The next day, use a paper towel to pick up one of the sandy cubes.

6. Hold the ice tightly against a piece of shale or limestone. Slowly push this across the rock several times. Examine the surface of the rock. The ice cube with sand acts like sandpaper. It should leave scratches on the rock surfaces. Try an ice cube without sand. What happens? The plain ice leaves no marks. When glaciers move across land they pick up and redeposit rock materials. Some of this rock material scratches and gouges rock surfaces on the earth.

Adapted from *NATURESCOPE*, the National Wildlife Federation, Vol. 3, No. 2.

NO GREAT SHAKES

Objective:

Students will construct a simple **seismograph.** A seismograph is basically a free-hanging pendulum, held steady in a vertical plane by its weight. A seismograph can record some of the slightest tremors and give warning of possible quakes.

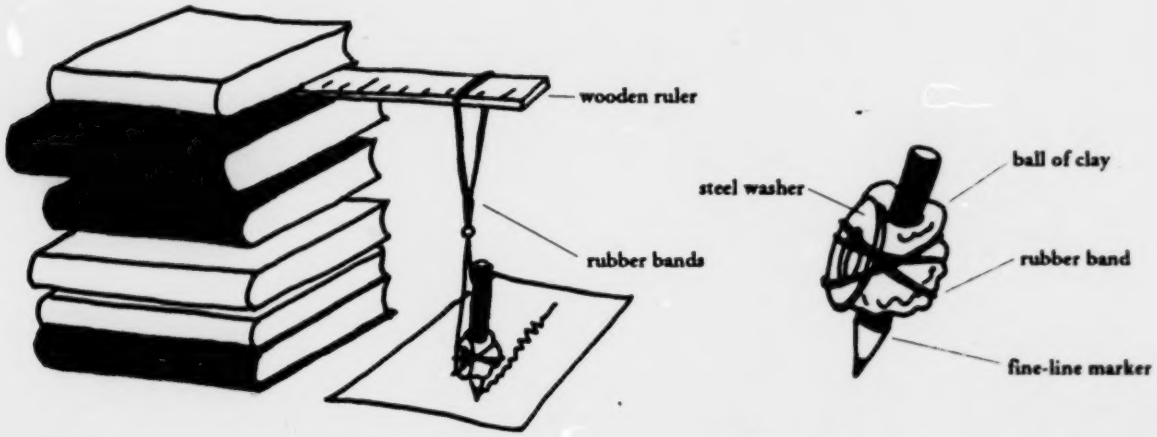
Materials:

- 7-9 heavy books
- ball of clay
- thin-line felt marker
- level table area
- 3 extra-long rubber bands
- large metal washer
- strip of paper 35cm long
- standard ruler 20-30cm long
- metric millimeter ruler
- scissors

Procedure:

1. Stack the books in a pile on the table. Insert the ruler between the top two books with two thirds of the length protruding. Tie two rubber bands together the long way, tying one end to the washer.
2. Remove the cap from the pen and connect the washer to the inky end with the other rubber band (see illustration). Use the clay to connect the washer to the pen and to add weight. Hang this from the ruler by the top end of the rubber band so that the pen tip just touches the table. Adjust the height by changing the stack of books. Place the beginning of the paper just under the tip of the pen.
3. One student should gently move the table back and forth horizontally while another gently pulls the paper under the pen. Label the paper "Gentle".
4. Repeat the experiment two more times shaking the table harder each time. Label each paper and compare the results. The greater the movement, the greater the **wave amplitude** recorded. Scientists base Richter magnitude on wave amplitude; the higher the amplitude, the higher the Richter magnitude. Which student seismograph reading would h[illegible] the highest Richter reading? How is the amplitude related to the degree of force?

Adapted from *EARTHQUAKES.* NSTA/FEMA, 1991.



BAKEQUAKE

Objective:

Earthquakes result from specific movements and conbinations of movements below the earth's surface. Students will explore the effects of these types of earth motions. Scientists think that many earthquakes are caused by movements of **lithoshperic plates.** Pieces of the earth's crust float on hot, liquified rock on the mantle. When plates collide, separate, or slide along each other, earthquakes can occur. The magnitude of the quake varies with the amount of energy released by the plate action.

Materials:

For one cake per demonstration:

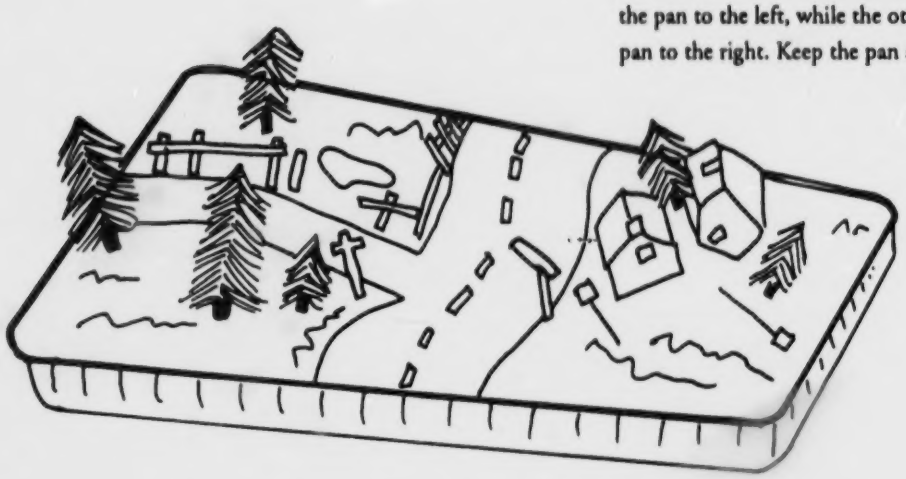
- two foil cake pans (30 x 40cm)
- one cake mix, prepared
- pair of shears to cut pans
- 10 x 40cm sheet of aluminum foil
- spray cooking lubricant
- red balloon

Procedure:

1. Prepare one cake for each demonstration. For each cake cut one of the foil cake pans from side to side starting below the rim. Leave the rim intact to hold the pan in position. (For the lateral plate movement demonstration, cut one pan on the diagonal.) Reinforce the cut pan by covering the outside with aluminum foil. Place the foil-reinforced pan inside the second, un-cut pan. Lubricate the inside of the cut pan generously with cooking spray.

2. Mix and bake the cake according to directions. Layer two different flavors for a more effective demonstration. Add nuts or chocolate chips for rocks, etc. Completely cool the cake before using. It is best to prepare the cakes needed at one time. Remove the inner pan containing the cake and cut the rim. Be careful not to fracture the cake. Frost the cakes with different colored stiff frosting to represent roads, streams, grass, etc. Use small toys to add details such as houses, trees, etc.

3. Demonstrate **lateral plate movement** (using the pan cut on the diagonal), by having two students each hold the ends of the pan. One student should slowly move half the pan to the left, while the other student moves the pan to the right. Keep the pan as level as possible.



4. Demonstrate **divergent plate movement** by having two students hold another cake in a pan at both ends and slowly pull outward, without twisting. When the pulling stops, the cake does not snap back to its original condition. After an earthquake, the earth does not return to its original position. Fissures in the earth do not close up but are filled with debris over time.

5. Demonstrate **convergent plate movement** using another cake. Before baking this cake, slightly bend the bend the cut pan so one side will slide into the other. Have two students hold the ends of the pan and slowly push toward each other. The cake should buckle in the middle, just as the earth's surface lifts and folds from colliding lithospheric plates.

6. Some types of magma flow stop and cool before reaching the earth's surface. These form **domes** or **laccoliths** by pushing up the crust. To demonstrate this, use another cake and a red balloon. After cake is prepared, carefully remove it from the pan and insert the balloon through the cut crack so the open end hangs below the pan and the top is under the cake. Replace the cake. Have two students hold the ends of the pan and a third student blow up the balloon from underneath. The cake should bulge just as the earth's crust does when magma escapes and spreads out under the surface.

Adapted from *SCIENCE AND CHILDREN.* September, 1991.

MINERAL MAGIC

Objective:.
Students will explore the mineral properties of color, luster, hardness and streak in learning to identify six common minerals.

Materials:
- samples of quartz, graphite, pyrite, hematite, galena and halite
- streak plates-unglazed porcelain, pennies, steel files, index cards
- hand lenses
- copies of rock and mineral field guides
- paper, pencils

Procedure:
1. Set up stations around the room for students to use in groups. Each station should have a numbered index card (Station #1, etc.), a streak plate, a lens, a penny, a steel file and a mineral sample. Pass out a copy of the mineral chart to each student.

2. Using quartz, walk through the property tests with the students. Do not identify the mineral. Students can fill in the charts as you go along. Explain the properties the students will explore, and that test results may vary depending on the quality of the samples.

- **color** - the identifiable color. (Quartz may be colorless, whaite, pink, smokey, yellow, or purple.)
- **streak** - the color a mineral leaves behind when it is scratched across the plate. (Quartz leaves a white streak.)
- **luster** - the way a mineral reflects the light. (Quartz has a glassy luster.)
- **hardness** - if a mineral can be scratched with a fingernail it is considered very soft; with a penny, it is soft; with a file, it is medium; with none of these it is hard. (Quartz cannot be scratched with the file it is so hard.)

#	Color	Streak	Luster	Hardness	Name
1					
2					
3					
4					
5					
6					

3. Students should work in pairs to determine the properties of the other five samples. When the charts are completed, present the information on the chart, in mixed up order, and have students compare their data to identify their samples. Repeat the tests using schooly ard samples.

4. Other tests that may be performed include:

- **cleavage** - the way a mineral can be split or broken. Minerals cleave in one or in many directions. Use a small hammer and WEAR SAFETY GOGGLES. (Quartz shows rounded, well-shaped breaks.)
- **calcium carbonate presence** - vinegar can be used to test for calcium carbonate. A few drops placed on the sample will fizz if calcium carbonate is present - this is the prime ingredient in sedimentary rocks. (Quartz will not react at all.)
- **magnetism** - use a small magnet to test for the presence of metals.
- **piezo electricity** - some crystals (quartz is one) produce electricity when they are stretched or compressed. Strike quartz samples together several times and they will flash like heat lightning. The pressure builds up voltage and electricity is discharged with a spark. Conversely, electricity applied to the crystals will cause them to deform or move about.

COLOR	STREAK	LUSTER	HARDNESS	MINERAL
grey	dark grey	metallic	soft to medium	galena
colorless (may have tints of color)	white	glassy	soft	halite
colorless, white (may have tints of color)	white	glassy	hard	quartz
brassy yellow, gold	blackish	metallic	hard	pyrite
grey	grey, black	dull, metallic	very soft	graphite
grey, black, red, brown	dark red, reddish-brown	dull, metallic	hard	hematite

Adapted from *MUSEUM OF SCIENCE* Rocks and Minerals kit.

HANGING BY A THREAD

Objective:

Students will explore the process through which **stalagmites** and **stalactites** are formed in caves.

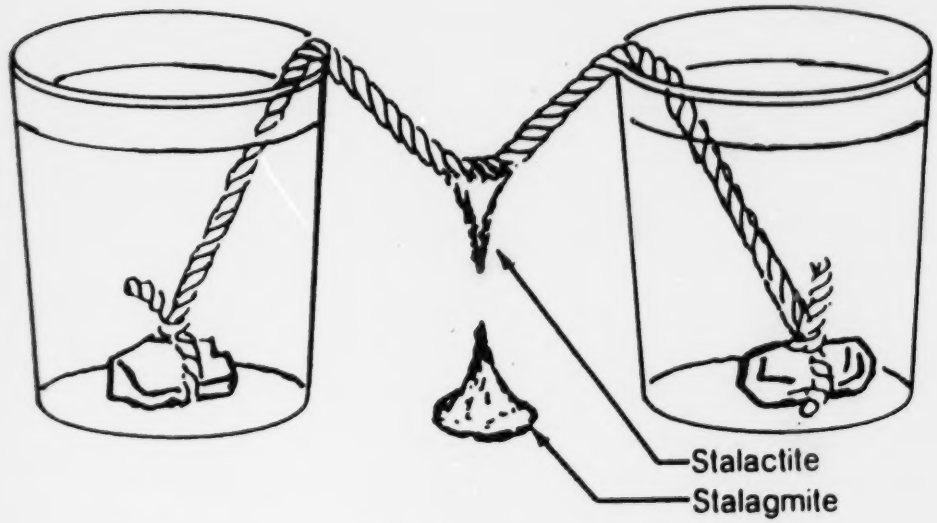
Materials:

- two, quart glass jars
- 24" piece of soft yarn
- hot plate
- 8 ounce powdered alum
- water
- two small rocks

Procedure:

1. Heat water and fill the two glass jars. Stir the powdered alum into both jars. At each end of the yarn tie one rock, and then place a rock in each jar.
2. Form a loop between the jars as shown in sketch. Then place the model in a corner on a washable surface and out of the way. After several days, a small salt-icicle will begin to form on the bottom of the yarn loop. As the salt water drops on the surface from the loop, a small salt-icicle will begin to rise from the surface.
3. The salt-icicle forming on the loop is called a **stalactite.** The icicle forming on the surface and rising is called a **stalagmite.** In many caves stalactites and stalagmites are formed by water absorbing salts and then evaporating, leaving the salt deposited in icicle shapes. Think of hold "tight" to the ceiling to distinguish the terms.

Adapted from *SCIENCE ACTIVITIES FOR ELEMENTARY CHILDREN* by Nelson and Lorbeer. Little Brown, 1984.



OUR FLOATING CONTINENTS

Objective;
Students will set up and observe a model of the **aethenesphere** and the movement of continental plates upon it.

Materials;
- 1 small electric hot plate or bunsen burner
- 8 inch diameter sauce pan - wider is better
- thick puree of beans or peas—just fluid enough to flow up and away from the center when heat source is turned on. Try this ahead of time.
- one matzo or cracker for each four students.
- copy of Pangaea map.

Procedure;
1. Start the puree warming (start with low heat and increase gradually).

2. Read *In the Know* or tell the students the two theories of how the continental plates move. Explain that the class is going to set up a demonstration using puree as molten aesthenosphere and continents reproduced from crackers. As they watch what happens they are to decide which theory seems to be confirmed by their puree model.

3. Form teams of four students, and provide each team with a map of Pangaea. Assign each team one continent to chip out of matzo. **It does not need to be perfect as we do not know the exact shape.** Place the cracker pieces in the center of the pot according to the diagram of Pangaea. As the puree warms, the crackers will begin to move apart. Some may sink if they sit on the edge of the pot or get bumped by other continents. Have each team record what happens and decide which theory is supported by the model.

4. Discuss what is happening in the center of the pan? Why do you think this is taking place? What do you see that supports what you think? What is happening at the edges? How is this model different from the planet Earth? (Earth is a continuous sphere and the puree just a flat surface.) What reasons make you uncertain of your conclusions about the best theory.

5. Scientists are still trying to find out what really happened. Students can develop their own new theories as long as they have evidence to support them.

By Arlene Nichols, Science Consultant.

Our Floating Continents Puzzle:

METAMORPHIC POETRY

Objective:
Students will simulate the process which creates **metamorphic rocks**. Metamorphic rocks form when intense heat and pressure within the Earth change the mineral structure of igneous and sedimentary rocks.

Materials:
- 2 heavy books or flower press
- molten "igneous rocks" (recipe in Too Hot to Handle)
- other rocks-gumdrops, mini-marshmallows, chocolate chips
- waxed paper

Procedure:
1. Use the books or flower press to represent the sediments or rocks that press down on the igneous rocks beneath.

2. Make a ball of "molten magma" (see Too Hot to Handle) and blend in the other rocks (gumdrops, etc.) Place the ball between two pieces of waxed paper.

3. Center this igneous sandwich between two large books or in a flower press. Every other day add more weight or increase the pressure on the press. After a week, examine the igneous rock.

4. It has become a "metamorphic rock" because its structure has changed as a result of being under pressure over time. Let the new rocks harden and add them to the artificial rock collection.

by Beverly Maffei, Editor of SCIENCE IS ELEMENTARY and Arlene Nichols, Science Consultant.

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Volume 4
Volume 5

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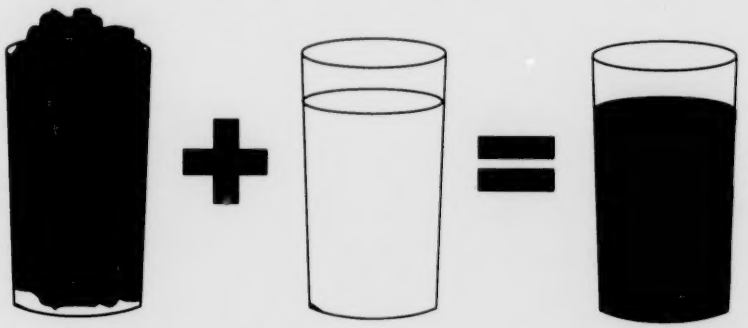
Math and Science Integration



Science

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• *is* ELEMENTARY

A SCIENCE TEACHING RESOURCE PUBLICATION

In this issue:

Math and Science Integration

M I T S, Inc. • *Museum Institute for Teaching Science*

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Mission

The Museum Institute for Teaching Science was started in 1983 as a collaboration of seven (then eleven) museums across Massachusetts for the purpose of increasing and improving the teaching of science in elementary and middle schools. After a series of successful workshops funded by the National Science Foundation, the federal Department of Education and private foundations and corporations from 1986 through 1991, and the development of a resource publication for teachers, *Science Is Elementary*, the directors of the collaborating museums advised that it was time for MITS to become a separate entity.

MITS, Inc. was incorporated in June of 1992. The purpose remains: the teaching of participatory, inquiry-based science, math and technology in elementary and middle schools. This goal is achieved by promoting cooperative ventures between institutions of higher learning, museums, businesses, federal and state agencies, and schools. These ventures include workshops, conferences, and a resource publication to promote continuing professional development for teachers, museum educators and school administrators.

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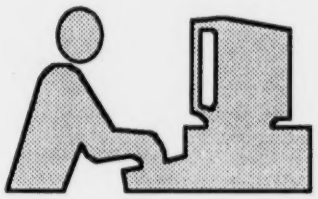


Brief Brief

I apologize for the delay in this issue. We have been changing computer systems and are now completely on-line. This issue provides some interesting avenues for thought about interdisciplinary curriculum. The *In The Know* section focuses on new initiatives that provide working models of ways to integrate math and science for the needs of the 21st century. The iniatives mentioned only touch the surface of the changes going on. Many of the most significant changes are occurring at the local level in individual classrooms. Every new century means changes, and I believe the buzzwords for this one should be *flexible* and *resourceful*. Flexibility of thought and purpose, and resourcefulness of ideas and applications are necessary for our survival in a high-technical age. More and better learning can take place when knowledge for meaning becomes an integral part of every curriculum. The *Trade Secret* provides information on establishing and maintaining science and math clubs and fairs as forums for student learning and expression. *Sciencing* activities integrate mathematics as a tool for expressing information in science and are not focused on any one topic. They can be easily adapted to all curriculum areas. Science can be the centerpiece and math the tool for exploring many topics generated by student interest as well. Let me know what you think.

I also want to thank the readers of **Science is Elementary.** Your continued interest in this publication has kept me going. In 1992 I won a Presidential Award for Teaching Science, and part of my appreciation goes to MITS, Inc. and the readers of SIE for making that award possible. If not for you, I would not be sciencing today.

This issue focuses on the integration of math and science. Before any discussion is valuable, teachers must have some understanding of current thinking about math and science teaching. Twenty years of research has shown that children learn best when information is meaningful and presented with a real-life application component; students DO NOT learn best simply drilling. Manipulatives and the project approach have been proven to work, not only for immediate classroom lessons, but for higher-thinking applications throughout all of an individual's learning lifetime. "Play" with objects helps to develop relationships and understanding of various relationships helps to clarify ideas. "Manipulating" variables in an experiment, funds for a bank, or toothpicks for building a bridge, are all examples of theory application. Inquiry-based education involves students in their own learning by having them practice skills in real problem-solving situations. Hands-on math and science are inquiry-based if students are asking questions and then devising experiments to find answers (or to find more questions).

Mathematics is the language of science. It is impossible to teach one without the other. Science is a content subject while mathematics is a tool subject. It is vitally important to recognize the connection between the two, and to teach them together. Both disciplines are oriented toward hands-on applications, experimentation, and computer technology. Geometry, statistics, graphing, estimating, calculating, measurement, and algebra are some of the mathematics topics that assist students in science. By combining the teaching of math and science,students will learn that math lays a solid foundation for studying science. The twenty-first century will require individuals who are flexible, resourceful, and adaptable. An integration of math and science is a step in that direction. This is an exciting time of change – a renaissance of education for meaning. This could also mean a rebirth of autonomy as the aim of education. There are national initiatives aimed at increasing math and science literacy by interrelating the subjects in a real-life project approach. The principle is simple - make math and science education relevant through hands-on activities, integrating study of related subjects, and using technology to facilitate discovery-based experiences.

The National Council of Teachers of Mathematics has released several reports that outline a new vision of math instruction grounded in the principle that students learn math by doing it in purposeful ways. Their recently issued groundbreaking standards, **Curriculum and Evaluation Standards for School Mathematics** and **Professional Standards for Teaching Mathematics**, are guidelines for bringing math learning into the twenty-first century. These standards shift math learning away from classrooms as collections of individual learners and toward classrooms as math communitites. Businesses need personnel who can work as teams, a "collective brain" so to speak. The new standards applaud mathematical reasoning, not only memorization of procedures. Conjecture, invention, and problem solving are the new bywords. The process is as important as the correct answer. Student math experiences should develop in them an appreciation for the role math plays in contemporary society, and how math relates to all subject areas. Many school districts are attempting to implement these new standards through increased application of technology. Computers and calculators can become powerful learning tools through which students can record data, apply skills, and interrelate ideas. Teachers need training in developmental math learning theory and many areas need supplies. There is still a way to go. It is both frightening and stimulating at the same time; being part of the rebirth.

The American Association for the Advancement of Science in their report, **Project 2061**, outlines the knowledge, skills, and attitudes that all students should acquire as they advance from K-12. The project is named for the return of Halley's Comet in the year 2061. Phase One of the plan focuses on determining the specific knowledge and skills

students should acquire. Phase Two will transform the Phase One ideas into working curriculum models in school districts. Phase Three will be a nationwide push to implement the project. The report says that science teachers should care about meaningful learning, not just facts. Therefore the project is working toward radically reducing content and increasing process so that significant topics can be pursued in depth and in different contexts. Proper education should also give students a sense of the relevance of what they are studying. Relevance to their own problems and those of the world. Computers are to be used in all stages of the process: to gather data, design a product, analyze data, and record results among other things. The science report has a heavy influence of social sciences as well, because the Project maintains that cultural influences and interpretations are important in the big picture. To arrive at the specific knowledges recommended for each grade level, Project 2061 engaged in a process called "mapping". Mapping is simply thinking through the progression of learning from kindergarten until graduation, and identifying conceptual stages and interconnections, or "benchmarks", needed to achieve particular learning outcomes. This is a process most teachers go through when planning a year's curriculum. But the thrust is different. The project takes into account how children learn. And rather than focusing on facts to remember, focuses on ways to learn how to learn more.

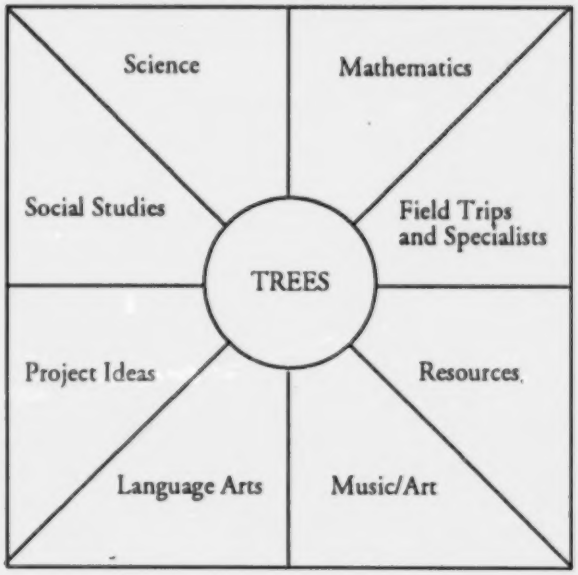
There are many local initiatives in place in schools, in partnerships with universities, and in collaboration with state departments of education. Reform is a slow but necessary process. For example, the Massachusetts State Department of Education is initiating the PALMS Project, *Partnerships Advancing Learning of Mathematics and Science.* The project hopes to systemically change and improve the way mathematics and science are taught and learned in PreK - Grade 12 classrooms, and adult learning centers throughout the state. The Palms model involves several components. A curriculum framework will assist educators in developing math and science curriculum centered around project-based learning that addresses real-life problems. Each curriculum will list learning outcomes, materials and resources, recommended published materials, and alternative assessment strategies. A professional development program will provide participants with necessary skills and knowledge needed for improving math and science education. A preservice teacher preparation program will train new teachers in integrated and project-oriented models. A telecommunications network will offer direct access to mathematicians, scientists, and technology experts throughout the world. A community outreach program will help to disseminate the message to the public as students with better math and science skills are vital to society. And an evaluation and assessment program will provide educators with information and examples of new assessment techniques.

Northeastern University in Boston sponsors the Project SEED program, Science *Education Through Experiments and Demonstration.* Teachers are involved in a summer workshop component that increases their confidence in using inquiry-based models for integrating math and science. A more recent component of that program is Project Re-SEED, the RE standing for retired engineers. These scientists are trained and then put into middle school science classes to model the hands-on approach.

The *Educational Development Corporation* (EDC) in Newton, Massachusetts has developed the Journey in Mathematics curriculum, a new model for mathematics education in grades 4-6. Students connect mathematics to fundamental aspects of the human experience: discovering, creating, building, planning, and playing. Many other educational organizations can provide valuable integrative units or curriculums.

Does all this change sound frightening? Many teachers feel they don't have enough time in the day to provide for all their present curriculum requirements. That argument works if thinking about schools remains in the 1950's. These are the soon to be 2000's and thinking has changed. Time blocks for math, science, reading and other subjects are not fluid enough for the kind of thinkers society will soon require. Workers must be collaborative and inventive. To reach that point, teachers must begin to think about curriculum in a new way.

Instead of blocking out subjects, begin to think of curriculum in terms of a central idea. Science topics provide endless possibilities. A study of mammals as the theme, for example, can involve students in all other disciplines: reading about mammals for information and through literature; writing research papers, reports, plays; graphing types of mammals estimating sizes of largest and smallest mammals, developing time lines of mammal evolution; drawing and creating mammals; singing mammal songs; identifying mammal characteristics; and locating various mammals in geographic areas. At the primary level, learning centers can function as areas where various activities take place, or groups of children can research and present information on various parts of a theme. At the intermediate and middle school levels, teachers can work together to develop curriculum corresponding to a chosen theme in their particular disciplines. Skills can be taught and checked in small groups within the framework. Below is an example of a theme planning sheet. The first step is brainstorming - alone or with colleagues - about everything students should know about an idea or topic.



We all must understand that a new century (and every century turn before us) has brought with it significant rethinking of what we are doing and why we are here. The information age is giving way to the higher technology age, and it is far more exciting to be a part of it than to fight against the tide. Call around to see what programs or courses are available inyour area.

This month's "secret" focuses on **science** and **math clubs** and **fairs.** The formation of clubs and the planning of science fairs is not difficult. Important requirements are excited students and an interested teacher or parent. If the focus is on group inquiry, no one needs to be an expert, the group will learn together. Science is often collaborative. Math is the language of science. The connection is natural and this cooperation should be part of all math and science events at any level. Girls and boys with different skills can each make unique contributions to an idea or to a project. Well run clubs can bring peers together for support, feedback, and discovery. Well organized fairs can make the research and creation of an exhibit a learning experience which might lead to a deeper interest.

Science and math are competitive at times. Individuals may be involved in researching the same topic but are working alone and many times at odds. Teams may work on the answer to a problem together, but rely on outstanding individuals. Competitors may improve their skills by trying them out and by receiving expert coaching. State, national and international competitions exist that groups can easily get involved with. Details, dates and rules change from year to year so interested groups should contact agencies directly.

The potential for significant education exists through science and math fairs and clubs. The best offer experiences that involve learning by doing with the help of mentors (teachers, parents, interested adults). The feedback that occurs from student to student in a club can be a valuable learning tool. Science or math competitions can fulfill a function similar to the presentation of a scientific paper to the community. Contestants and participants can exchange ideas, and gain confidence, knowledge, scholarship, and skills as a result of the inquiry process, whether or not they actually compete.

CLUBS

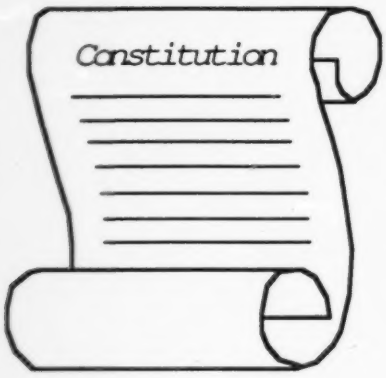
A well-run club should have elected officers, a written constitution and by-laws, and a series of annual activities. Clubs should allow individuality and provide a forum where ideas can be tested. Clubs offer both science/math and socialization. Many students feel the need to share interests or to be heard above a larger group. Clubs provide peer support, recognition, and a conduit to the professional worlds of math and the sciences. They are avenues through which members can practice inquiry methods and analyze results. Students need a place to communicate their findings and share their work. All participants grow. Extra-curricular clubs can extend learning time for members and the larger school community through competitions, trips, guest speakers, and fairs.

The first step in starting a club is persuading the administration to accept the club's goals. These can be many, but some examples are to:

- stimulate interest in science or math activities in a fun way
- broaden academic endeavors of the school
- help students realize the relationship of science/math skills to the real world
- include the school in community science/math activities
- promote science/math thinking as a way of looking at the world

The science and/or math departments should be involved as it may take all faculty members to help meet goals. In addition, affiliations with state and national clubs and organizations can increase interest and widen the possibilities for learning and exchange. Information reaches a wider audience and members can take advantage of competitions and awards. These organizations can also help expose an individual club to the science/math community.

After goals are formulated and approved by the department and administration, club members should prepare a budget and a meeting/activity schedule. Confront all logistical details (time, transportation, permission slips, etc.) at the start if possible. Plan at least one annual activity that the community will start to anticipate. Keep the club flexible to meet the changing needs of students year to year. Consider club finances at the outset as money will be needed for trips, materials, affiliations, and competition entries. Dues, contributors, fund raising activities, local businesses, and school funds are all sources of income. Detailed financial records should be kept.



The next step is to write the club constitution. It should provide for electing officers, membership eligibility, protocol at meetings, and the club's purpose. The constitution should complement the school policy and provide for any necessary deviations. The constitution should spell out procedures to follow in specific situations, such as whether or not a student on academic probation can participate. Elected officers should be fully aware of what they are expected to do. A basic constitution should include eleven "articles" and sections within the articles.

- Article I. **NAME** (The name of the club.)
- Article II. **PURPOSES**
  Section 1. To...
  Section 2. To... (etc.)
- Article III. **OFFICERS AND DUTIES**
  Section 1. President shall....
  Section 2. Vice-president...
  Section 3. Secretary...
  Section 4. Treasurer...
  Section 5. Director of Public Relations...
  Section 6. Historian...
  Section 7. Librarian...
- Article IV. **QUALIFICATIONS/DUTIES OF SPONSORS** *Section 1.* (etc.)
- Article V. **MEMBERSHIP**
  Section 1. (etc.)
- Article VI. **MEMBERSHIP DUES**
  Members shall pay an annual dues of...
- Article VII. **MEETINGS**
  The club shall meet regularly at...
- Article VIII. **ELECTIONS**
  Officers shall be elected annually by secret ballot.
- Article IX. **QUORUM**
  A simple majority of members shall constitute a quorum.
- Article X. **COMMITTEES**

  Section 1. President will serve on all committees.

  Section 2. Committees: program, social, promotion, membership, finance, and service.

  Section 3. Committee chairs shall be appointed by the president.
- Article XI. **AMENDMENTS**

This constitution may be amended by a two-thirds vote of the membership at any regular meeting. Written notice of the proposed amendment must be filed with the secretary and presented at the meeting prior to the one at which the vote will be taken.

A core group of interested students should be at the heart of the club's formation. They should be involved in all areas of inception. The teacher/advisor's job is to moderate, arrange logistics, keep order, offer encouragement, and give guidance. Many parents may have support and expertise to offer, and might be included. It should be clear to all members that this club is for them, to meet their needs. Every member has the potential for making the club a success. Club activities should be included in the school and community newspapers. Beginning the club from scratch will be a learning experience in itself. The more students are involved, the more investment they will have in the club's success.

FAIRS

Planning is the key to a successful science, math, or integrated fair. The fair concept provides students with a forum for presenting an in-depth, hands-on research experience. Teachers act as models and coaches, students can let their individuality and creativity run free. A fair should be an opportunity to present research and conclusions about real problems. It should not be a collection of exploding papier mache models or an art exhibit. Judging should be instructional, an opportunity for researchers to discuss their findings with experts in order to expand their knowledge. Fairs may also take the form of "invention conventions".

Begin by forming a *fair committee.* Draft everyone who is enthusiastic or offers help. It is best to work across curriculum departments so no one's schedule is disrupted without their knowledge. English teachers can help with promotion, art teachers can act as design advisors. Parents should be recruited to support projects and serve as community liaisons.

Decide whether the fair will be math-based, science-based, or integrated; and if participation will be mandatory or voluntary. The choice will depend on your curriculum and needs. Required participation brings many teachers and students together with a common goal. Projects come under class requirements and can be better monitored. Students previously uninterested, may discover a new enthusiasm for math and/or science. It results in an impressive, well-attended fair. Voluntary participation reduces the number of student and parent complaints. Quality may be higher because only the interested are involved. There are several ways of approaching the dilemma. Science/math fairs could be related to clubs, might be selected as elective courses, or might be mandated for specific grade levels (grades 7 and 11, for example.) It should also be determined whether projects need to be completed individually, or if cooperative grouping is acceptable.

The committee should then establish a *working calendar.* Set the fair date and work backward to determine dates for accepting project application forms, contacting judges, arranging for display areas, obtaining awards. Reserve facilities for a full day to ensure adequate time for set-up, judging, public viewing, and the awards ceremony if there will be one. Several chairs and sub-committees are necessary to coordinate all aspects of the fair. Individual needs will determine how many of these positions are necessary.

- **Liaison with Science Teachers** communicates with faculty and designs application.
- **Secretary** takes notes, writes promotionals, invitations, programs, thank-yous, and keeps record of all procedures for next year's committee.

- **Coordinator of Judges** solicits judges (1 for every 4 projects), designs judging form, and develops point system. Provides refreshments for judges on fair day. Three standard judging questions are:

  What is the purpose of your research?

  What are your variables and controls?

  What will be the next logical step in your research?

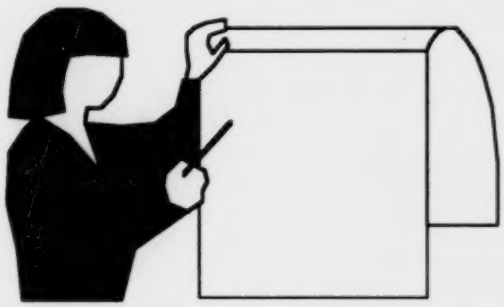
- **Publicity Coordinator** advertises the fair, writes press releases and acts as community liaison.
- **Awards Coordinator** develops a recognition for every participant, and solicits donations for awards.
- **Educational Display Coordinator** may solicit displays from agencies and industry to enhance the fair, or if not, be in charge of equipment needs for the fair.
- **Review Committee** reviews applications and monitors student progress.

The committee should help students decide on topics and set reasonable limits. Student raised questions should be able to be examined within the confines of school and community resources and equipment. A simple format: form hypotheses, establish research designs, engage in project, display results - should be the norm. Committee expectations should take into account student age, experience, enthusiasm, and availability of assistance. For example, if students have never engaged in research they will have no idea where to start. It may be helpful to model a project procedure by having the whole class participate in an in-class project. Teachers should call attention to the specific steps as they occur and generate student discussion. Teachers may also want students to keep a "project journal" as a record of everything they went through during the project. Journals should include all notes, drafts, and questions about the project.

The committee should decide if presentations will include visual displays and oral presentations, and should provide models from which students can work.

Elements of a Poster

- title
- topic headings
- topic heading captions
- topic text
- references
- figures



Elements of Oral Presentations

- state the problem (background)
- state the question being researched (problem)
- state the hypothesis of research (your best idea based on what your know)
- state the theoretical base (scientific thinking of the subject)
- state the methods and materials (how project was done)
- state results (what you found)
- confirm or negate hypothesis (what was proved)
- discussion (implications of research)

More information on science and math fairs is available from state science and math associations. It is best to make the connection at the local level if you are just starting out. Math and science coordinators or department heads should have titles and addresses. The following brief list of companies sponsoring science and math events is a place to start, but contact them directly to get updated information, rules, and eligibility requirements.

SCIENCE

National Merit Competition
Apple Computer Clubs
Apple Computer, Inc.
20525 Mariani Avenue
Cupertino, CA 95014
(408) 996-1010

Dow Preseents: The Art of Science
New York Academy of Science
2 East 63rd Street
New York, NY 10021
(212)838-0230

Duracell NSTA Scholarship Competition
Duracell Competition
1742 Connecticut Avenue, NW
Washington, D.C. 20009
(202) 328-5800

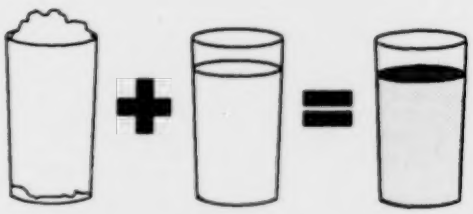
Science Olympiad
Science Olympiad
5955 Little Pine Lane
Rochester, MI 48064
(313) 651-4103

MATH

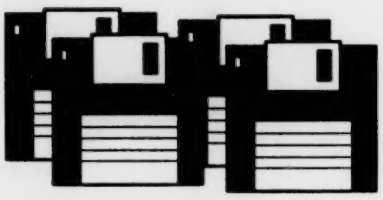
Continental Mathematics League
Continental Mathematics League
P.O. Box 477
Hauppauge, NY 11788
(516) 265-4792

National Mathematics League
National Mathematics League
Box 9459
Coral Springs, FL 33075
(305) 344-8980

Mathematical Olympiad
American Mathematics Competitions
Dept. of Math and Statistics
U. of Nebraska
Lincoln, NE 68588
(402) 472-2257



The ideas presented, constitution format, ideas for fairs, and agency lists were adapted from *SCIENCE AND MATH EVENTS: CONNECTION AND COMPETING.* NSTA, 1990. Be sure to read it for more complete information and a longer list of mathematics and science events.



Several simulation disks are available for grades 4-8. *Math Quest* is an adventure simulation focusing on math problem-solving techniques. It includes skill development in six areas: using a table, chart, or list, drawing a picture, acting it out, finding a pattern, guessing and checking, and working backward. Students travel through four mysterious lands. *Galaxy* is a simulation of a space society on the brink of civil war. A student handbook, sets of the Galaxy times, confidential identities and teacher guide are included. *Science Fair* is a simulation of a school mystery that teaches science skills needed to create a successful science fair project. *Explosion* is a simulation of a society's struggle to solve its population problems from the years 1980-2015. And *Chow* is a simulation of nutrition and food budgeting. It contains student guides and teachers set-up instructions.
INTERACT Elementary Simulations
P.O. Box 997-Y92
Lakeside, CA 92040
(800) 359-0961

Timeliner, for grades K-12, allows students to create time lines up to 99 pages long.
The *Science and Technology* component makes science, invention and technological advancement come to life with time lines such as: The Industrial Revolution, Space Exploration, and The Age of Computers. Any subject is applicable making this great for interdisciplinary studies. For Apple II family, IBM, and Macintosh. *Everything is Relative* enhances Timeliner by showing proportional relationships in distances, weights, speeds, and more. Grades K-12.

See You Later, Estimator is an interactive *video* that presents students with estimation problems at several levels. The video times responses and gets progressively more difficult so it can be used over and over. Included are estimations of simple groupings, geometric equivalents, sets and overlapping sets, rounding, and numeric comparisons. For grades 1-12. Even the most math-shy students will participate.
The two programs above are available from:
Tom Snyder Productions
90 Sherman Street
Cambridge, MA 02140
(800) 342-0236

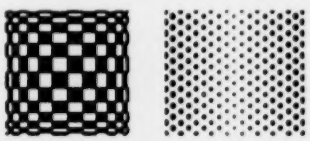
The Metric System allows students to learn to measure the length of objects in meters, centimeters, and millimeters; convert meters to centimeters and millimeters; add subtract, multiply and divide metric units; calculate area and volume; and describe the units of liquid volume and units of mass in the metric system. Available for the Apple family, IBM, and Macintosh, grades 5 and up.

How to Prepare A Science Fair Project is an interactive *video*. Partipating in science fairs can be a valuable experience requiring organization, planning, creativity and many hours of work. The program acquaints students with the many steps and procedures for preparing a science fair project. It emphasizes the importance of long range planning and helps students become organized in their approach. Describes selecting a topic, conducting research, developing a hypothesis, incorporating the scienticfic method into the project, organizing and writing papers, constructing and designing exhibits, and conducting an oral presentation.
The above two programs are available from:
Queue, Inc.
338 Commerce Drive
Fairfield, CT 06430
(800) 232-2224.

There are several programs that help develop estimation skills. All are for the Apple family, but different grade levels. **Estimation Strategies** introduces students to the various strategies used for computational estimation including ranges, rounding, front-end digits, compatible numbers, and clustering. Teachers can control access to individual programs and problem types, and can view and print student records. Apple 128K, grades 3-6. **Estimation Activities** for grades 4-8 presents five engaging games that require students to develop and use their estimation skill in order to be successful. **Problem Solving with Nim** for grades 3-8 is based on the ancient game of Nim. It helps students test their problem-solving strategies and logical-thinking skills. There are variations on the game of Nim-Fish Nim, Calculator Nim, Space Nim, and Moonlight Nim.

The above programs are available from:
MECC
6160 Summit Drive North
Minneapolis, MN 55430-4003
(800) 685-MECC.

The **Nature Park Adventure** for the Apple family, grades 2-3 is an interdisciplinary adventure game calling for students to solve mathematical challenges as they attempt to rescue rare butterflies. It uses a story that involves them as active participants in the events leading to the story's outcome. Students encounter activities that require them to recognize shapes, think logically, decipher codes, tell time, find true number sentences,use coordinates, follow compass directions, and spend money. Each mathematical problem has two levels of difficulty. Includes activities in identifying birds, recognizing leaves, and analyzing animal tracks. The teacher guide includes lessons in both math and science topics introduced in the software.



Muppet Math for the Apple family, grades 1-2 lets students discover that math is everywhere! For example, students may visit Kermit's art room and work with his geometric paintings or go to the gym and help Miss Piggy graph her exercise routine. This high interest program integrates many problem solving activities. The teacher can control the levels of difficulty in each of the activities to accommodate a wide range of abilities. The Teacher Guide contains lessons which complement the program's focus on math in the student's world. The innovative lessons integrate mathematics into many subject areas. One disk, backup, teacher guide.

Winker's World of Numbers and **Winker's World of Patterns** for grades 1-6 allow students to follow Winker through number patterns on a grid. This challenges students to use inference, sequencing and math skills to identify the number hidden by Winker. In the second program players follow the Winker worm through patterns composed of numbers, colors, and words as they learn to recognize patterns and determine missing elements. Clues to the pattern appear and reappear as Winker moves about the grid. Reinforces inference; memory; and recognitôn of numerical relationship, colors, and words. Apple family.

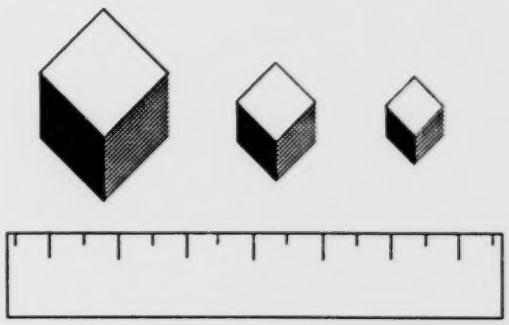
Maps and Navigation for grades 4-8 helps students learn the fundamentals of navigation to find buried treasure, avoid a hurricane and pinpoint their ship's location in order to call for help. These activities culminate in a rescue mission, a simulation in which students apply map skills amd mathematical concepts to help free a humpback whale caught in a fishing net. Apple ll or Macintosh. Backups, student guide, teacher guide. Can be used in conjunction with the astrolabe activity in this issue.

Hunt for grades 4-8 lets students search for hidden treasure on a tropical island, or rescue an alien princess. Provides students with practice in coordinates and compass bearing, while reinforcing problem-solving skills. Includes eight adventures. Students can create their own adventures and challenge each other. Each student-created hunt can be saved and printed.One disk, backup, teacher guide. Apple family.

Maya Math for the Apple family and grades 4-8 lets students work as "math archaeologists" to decipher the mysterious Maya base-20 number system. To succeed, they must articulate and apply their understanding of the base-10 number system. In **Maya Calculator** and **Maya Calender**, students experiment with Mayan numbers and convert Mayan calender dates to our own dates. In **Glyph Trek** students aquire familiarity with Mayan number notation through a treasure hunt game. Backups, student and teacher guides.

My Travels with Gulliver for grades 4-8 integrates mathematics, literature and writing. Through challenging activities students measure lengths and areas, estimate sizes, make size comparisons, and develop conceps of scaling and proportion. Students listen to a tape of Gulliver's adventures in Brobdingnag, a land of tiny people, and in Titania where everything is four times the size of comparable things in our world. Students use mathematics to gain a real sense of sizes of things in each land, solve problems within the story context, create scale drawings, and enhance their own stories. Students keep journals in which they record their observations, solve problems, and write about their experiences. Curriculum guide, student book, audio tape, poster.

All of the above programs are available from:
WINGS for Learning/Sunburst
1600 Green Hills Road
P.O. Box 660002
Scotts Valley, CA 95067-0002
(800) 321-7511



Doing Simple Math in Your Head. W.J. Howard. Coast, 1992. Grades 4 and up. Presents mathematical concepts clearly and provides techniques for readily learning mental math.

Sea Squares. Joy Hulme. Hyperion, 1991. Grades PreK-3. Presents a successful integration of science, language and mathematics. Sea creatures are characters in rhymes that explain mathematical concepts from simple counting to recognizing patterns and identifying squares of numbers.

49 More Science Fair Projects. Robert Bonnet and Daniel Keen. Tab, 1991. This is one of a series which includes Earth Science, Environmental Science and Computers. Provides an overview of projects, tips for choosing a topic and step-by-step methods for carrying it out. Includes sample projects and suggestions for expanding on original topics.

Science is an Action Word. Peggy Perdue. Scott Foresman, 1991. Grades 1-3. A teacher's guide to science-centered lab work in the primary grades. All pages are reproducible and experiments cover the scientific method, earth science, life science and physical science. Includes ample background and extension ideas.

Blue Ribbon Science Fair Projects. Maxine Iritz. McGraw-Hill, 1991. Grades 4 and up. Presents ten projects that have been performed by students in California. Includes original approaches, experiments and outcomes.

Joy of Mathematics and More Joy of Mathematics. Theoni Pappas. Wide World, 1990, 1991. Grades 5 and up. Both volumes are introductions to the complex world of mathematics. Ideas, puzzles, games, and historical notes are included. Some examples require previous knowledge.

Mathematics Made Simple. Abraham Sperling and Stuart Monroe. Doubleday, 1991. Grades 8 and up. Presents mathematical concepts in examples and includes practice activities. Provides real-life applications of the concepts discussed.

The Triumph of Discovery. Joan Dash. Messner, 1991. Grades 1-6. Outlines the lives of two women physicists and two women biologists, all Nobel laureates. Examines their accomplishments and obstacles in short, interesting biographies. The book also describes the work done by these women in a manner accessible to young readers.

Bridges. Ken Robbins. Dial, 1991. Grades K-6. Explores the style and structure of bridges. Locations of specific bridges are listed.

The Millionth Egg. Bernice Myers. Lothrop, 1991. Grades K-2. Hens attempt to lay the millionth egg. Great activity possibilities relating egg experiments and large numbers.

Peopling Of Planet Earth: Human Population Growth Through the Ages. Roy Gallant. Macmillan, 1990. Grades 5-8. An informative approach to the consequences of population growth. Includes a survey of the origin of life, rise of cities and migration. Glossary, index and bibliography.

Robots: Your High-Tech World. Gloria Skurzynski. Bradbury, 1990. Grades 5-8. The evolution of robots and their practical application is examined. Includes a timeline of robotics history.

The Time and Space of Uncle Albert. Russell Stannard. Holt, 1990. Grades 5-8. Although this is a novel, the character's science project and Uncle Albert's research provide an excellent introduction to Einstein's theory of relativity.

Exactly the Opposite. Tana Hoban. Greenwillow, 1990. Grades K-2. A wordless picture book of outdoor photos presenting opposite pairs.

My First Look at Sizes. Stephen Oliver. Random House, 1990. Grades PreK-6. Photographs present size progressions and comparisons with everyday objects.

Mathematics. Irving Adler. Doubleday, 1990. Grades 3-8. Opens the doors to mathematics by explaining concepts in accessible terms. Explanations are presented both on a calculator and a computer. Examples are clear and presented in real-life ways. Topics include numbers, the golden ratio, Fibonacci numbers, etc. Projects are simple and only a computer handling BASIC language is necessary beyond paper, pencil and scissors.

Science and Math Events: Connecting and Competing. NSTA, 1990. Adult. An informative guide for designing and delivering math and science fairs and competitions. Outlines how to get started and lists national clubs and organizations sponsoring events

Science in a Nanosecond. James Haught. Prometheus, 1990. Grades 3 and up. Presents a full range of scientific concepts in a series of 100 questions and answers.

The Sneaky Square and 113 Other Math Activities for Kids. Richard Sharp and Seymour Metzner. Tab, 1990. Grades 3-8. Provides teachers and students with a collection of math problems and puzzles that are fun and informative. The book is indexed by subjects and key words. Levels of difficulty are labeled.

Deep Down Underground. Olivier Dunrea. Macmillan, 1989. Grades Pre K-2. The movement of one moudiewort (Scottish for mole) sets off a chain of events. The reader encounters many species down underground while counting to ten. Pictures are wonderful.

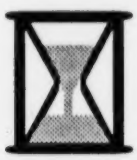
The Science of Music. Melvin Berger. Crowell, 1989. Grades 4-8. A book about music, sound and science. Discusses each instrument family, includes simple projects and touches on the math behind the music.

Anno's Math Games and *Anno's Math Games II.* Mitsumasa Anno. Philomel, 1987, 1989. Grades 1-4. Presents many games involving counting, numeration and measurement. Includes many picture puzzles. Also of interest is *Anno's Mysterious Multiplying Jar* which simplifies the concept of multiplication. (Putnam, 1983.)

Topsy-Turvies: More Pictures to Stretch the Imagination. Mitsumasa Anno. Philomel, 1989. Grades 3-8. Thirteen double-page spreads challenge the imagination with problems of scale and spatial orientation.

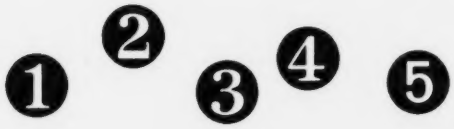
How Much is a Million and If You Made a Million. David Schwartz. Lothrop, 1985, 1989. Grades K-5. Both books explain the concepts of large numbers through great illustrations and similes. *How Much is a Million* is available in big book format from Scholastic.

Clocks: Building and Experimenting with Model Timepieces. Bernie Zubrowski. Morrow, 1988. Grades 4-7. An activity book that guides readers in making models to measure time. Includes sundials, water clocks, sandglasses and mechanicals. Brief history of time keeping is included.



Size: The Measure of Things. Eric Laithwaite. Grades 4-7. An introduction to the significance of size in natural and human-made phenomena. Includes activities, examples, a glossary and an index.

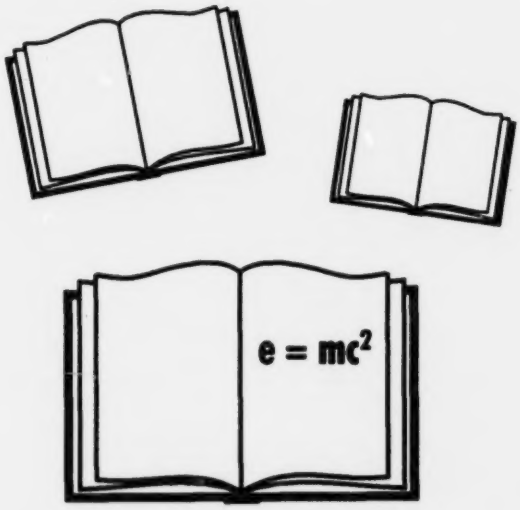
How Many Snails?: A Counting Book. Paul Giganti, Jr. Greenwillow, 1988. Readers count and classify objects according to similar properties and details. Readers learn to quantify and observe.



World of Wonders: A Trip Through Numbers. Eileen Doolittle. Houghton, 1988. Grades PreK and up. An innovative approach that counts from 1-12 using objects and old toys. Includes references to children's literature, lines from old songs, films and play titles, and number-related expressions to create elaborate collages that are linked by the poem. Schematic drawings provide a key to each illustration. Bibliography included.

Getting Started in Problem Solving with Math Contests. Micheal Ecker. Watts, 1987. Problem-solving strategies useful in math and science are explored. Techniques such as trial-and-error, working backwards, searching for patterns, shortcuts and changing perspective are demonstrated.

Activities for Teaching K-6 Math/Science Concepts. Walter Farmer and Margaret Farrell. School Science and Mathematics, 1989. Adult. Concepts are clearly presented and activities relate to students' physical environments. Adaptable to many grade levels.



Mathematical Byways in Ayling, Beeling, and Ceiling by H. A.Simon is a collection of 16 math puzzles in a detective format. The paperback costs $7.95 plus $1.50 postage and handling.
Oxford University Press
(800) 451-7556

The Cartoon Guide to Physics by Gonick and Huffman presents mechanics, electricity, and magnetism in a humorous format. The cost is $10 plus $2.75 shipping and handling.
Harper Perennial Books
(800) 331-3761

Award-winning California biologist **Sam LaBudde** blew the whistle on domestic tuna suppliers by documenting dolphin massacres with his video camera. He is now sponsoring a project to put *video cameras* in the hands of others who might be environmental whistle-blowers. Write for more information.
Earth Island Institute
300 Broadway, Suite 28
San Francisco, CA 94133

Science and Engineering Indicators is offering a free reprint entitled, *Precollege Science and Mathematics Education.*
Write for a copy.
NSF
Publications Office
1800 G St, NW, Room 232
Washington, DC 20550

The **Alliance for the Chesapeake Bay** offers free *River Fact Sheets* giving overviews of the history, charateristics, and problems facing Chesapeake Bay watersheds. Sheets are available for Maryland, Virginia, and Pennsylvania.
Alliance for the Chesapeake Bay
6600 York Road
Baltimore, MD 21212

TAB Books offers a catalog on their *Science for Kids* series, books on science fair projects and adult science titles.
TAB Books
Blue Ridge Summit, PA
17294-0850
(800) 822-8138

The **Iowa Department of Natural Resources** offers a free 50 page curriculum on peregrine falcons entitled *Recovering Our Heritage - Peregrine Falcons.* It includes history and activities and is geared for grades 3-8.
Iowa Dept. of Natural Resources
Wallace State Office Bldg.
Des Moines, Iowa 50319-0034

Teacher's Laboratory, Inc. offers free catalog of their *Science 5/13 Teaching Units,* the Piagetian-linked science series. Also available is a catalog on *Active Learning in Math and Science for PreK-8.*
Teacher's Laboratory, Inc.
104 Canal Street
PO Box 6480
Brattleboro, VT 05302-6480

Activity Resource, Inc. offers activity books that enliven mathematics concepts. Books are suitable for grades K-9. *Monthly Metrics, Making Metric Manuevers, The Metric System of Measurement, Merry Metric Cookbook,* and *Metrics All Around* cost $4.50 each. Also available are primary metric balance scales with mass pieces priced at $53.10.
Activity Resources, Co.
PO Box 4875
Hayward, CA 94540

The **International Council of Associations for Science Education** offers a $10 teacher resource book on the *history of Project Apollo.* It includes activities for grades K-12.
Jack Holbrook
Int. Council of Assoc. Science Ed.
Dept. Curriculum Studies
University of Hong Kong
Hong Kong, China

The **Hands-on Science Program** offers a resource book called *Putting Together a Family Science Festival* for $8.
Hands-on Science Program
4910 Macon Road
Rockville, MD 20852

The **Care Bears Environmental Kit** for K-3 students includes guide, activities, 25 copies of a student booklet, 64 stickers and four posters on recycling, energy and water conservation, and litter prevention. The cost is $9.99 inc. postage and handling.
Care Bears Kit
PO Box 44166
Cleveland, OH 44144-9926

The **Population Reference Bureau** offers *World Population: Fundamentals of Growth.* This guide includes maps, history, and activities and costs $5. Slides are available for $12. Add $1 or 3%, whichever is greater, when ordering.
Population Reference Bureau
PO Box 96152
Washington DC 20090-6152
(800) 877-9881

Zero Population Growth offers three teaching resources that help teachers relate math and science. *For Earth's Sake* examines the relationship between population and environment (#FRER, $24.95, grades 6-10); *USA By Numbers* increases critical thinking skills, chart reading, data interpretation, graphing, and communication (#USAT, $19.95); *Global 2000 Countdown Kit* relates population, resources, and the environment (#GLBL, $19.95).
Zero Population Growth
1400 16th Street, NW
Suite 320
Washington, DC 20036

The **National Academy Press** offers a 250 page book emphasizing the use of computers as tools to delve into mathematical concepts. *On the Shoulders of Giants: New Approaches to Numeracy* costs $17.95.
National Academy Press
2101 Constitution Avenue, NW
Washington, DC 20418

The **Association of American Weather Observers** offers a rust-proof, 11 inch capacity *rain gauge* for hydrologic and precipitation records. A rain diary, a sample data bank form, mounting hardware, and a free magazine are included. The cost is $25.95 inc. postage and handling.
American Weather Observer
Rain Gauge
401 Whitney Blvd.
Belvidere, IL 61008

The State of Louisiana offers **Classroom Archeology** a teachers' manual for grades K-12 that can be used in a variety of ways. Single copies are free.
Division of Archeology
Office of Cultural Development
State of Louisiana
PO Box 44247
Baton Rouge, LA 70804

Get a free catalogue of GEMS, *Great Explorations in Math and Science.*
GEMS
Lawrence Hall of Science
U. of California
Berkely, CA 94720

The **Rainforest Book: How You Can Save the World's Rainforests** explains threats to rainforests and ways students can assitst. Available for $7.95.
Natural Resources Defense Council
Box 1400
Church Hill, MD 21690

Request a catalog of wildlife prints. 16x20 are 99 cents each; 8x10 are 39 cents each. Add $4 for shipping and handling.
Wildlife Lithographs, Inc.
510 E. Fellows Street
Dixon, IL 61021

Basic Map Skills is a full color world atlas for grades 3-6 including activities on map concepts and the seven continents. It is also available in Spanish. Cost is $5.25.
Hammond, Inc.
Maplewood, NJ 07040-1396

The **Big Good Wolf** attempts to dispel myths about wolves. Adaptable for all grade levels. Cost is $6 including shipping and handling.
Honey Loring
Gone to the Dogs
RR #1, Box 958
Putney, VT 05346

The **Amazing Apple Book** and the **Amazing Egg Book** each include activities, history and lore, jokes, and recipes. The egg book also contains science experiments. Each book costs $6.95 plus 7% shipping and handling.
Addison-Wesley Publishing Co.
Route 28
Reading, MA 01867

Create a curriculum on whales using a step-by-step process. Any animal could be used. Cost is $9.
Elizabeth Rudinsky
270 Park Avenue South
Apt. PIB
New York, NY 10010

Sea World offers two guides which enhance classroom study of oceanography. *Killer Whale Fact Sheet* costs $3.50 and *Behavior and Training Curriculum* costs $4.50.
Sea World
1720 South Shores Road
San Diego, CA 92109

Three curriculums on water include lesson plans and other activities for grades 4-12. *Save Our Streams* costs $5, *Wetlands Watch* costs $3.50, and *Learning to Love Streams: Save Our Streams* costs $2. Include remittance with request.
Isaak Walton League
1401 Wilson Blvd.
Level B
Arlington, VA 22209

Minds in Motion: Using Museums To Expand Creative Thinking is a book suggesting ways for children to make visits to science, history, and art museums. The cost is $9.95.
Caddo Gap Press
1411 W. Covell Blvd., Suite 106-305
Davis, CA 95616

Laser Holography is a booklet of experiments to help students start making and understanding holograms. The cost is $1.50.
Thomas Alva Edison Foundation
3000 Book Bldg.
Deitroit, MI 48226

Water an environmental education program for junior and senior high school students includes a student reading and reference unit and comprehensive teachers' guide. It also includes information on water test kits using two methods to monitor pH, chlorine, hardness, dissolving oxygen and carbon dioxide.
Hach Co.
PO Box 389
Loveland, CO 80539

Wild Habitat posters on *Alaska Tundra, Coral Reef, Rivers of Life, Tropical Forests, Wetlands-Life in a Freshwater Marsh* and *Wetlands- Life in Salt Marsh* cost $6.95 each or $10.00 each rolled. Leaders guide for each is $2.00.
National Audubon Society
Attn. Orders Dept.
Route 1, Box 171
Sharon, CT 06069

Young Scientists Explore series (grades K-3) includes easy to produce science activity sheets on *Insects* (no. GA 403) and *Butterflies and Moths* (no. GA 452) for $5.95 each plus postage.
Insect Lore Products
PO Box 1535
Shafter, CA 93263

Posters on *Trees* - order # A7800429 and *Planting a Tree* - order # A7800428 cost $2.00 each plus postage.
Agricultural Bulletin
30 N. Murray St., Rm 234
Madison, WI 53715

Receive a free issue of a 1991 biological catalog of **preserved specimens.**
Nebraska Scientific
3823 Leavenworth St.
Omaha, NE 68105

Single copy of **AppleWorks Tip Twin Pack** with updated *Teachers' Best AppleWorks Tips* sheet and new *20Plus Tips for AppleWorks GS Users* is available for a SASE.
The AppleWorks Educator
PO Box 72, Dept. IM
Leetsdale, PA 15056

Science for Kids series includes several volumes: *39 Easy Geology Experiments, 39 Easy Meteorology Experiments,* and *39 Easy Plant Biology Experiments* are representative titles and each cost $9.95. For ages 8-13. The **Science Fair Project** series includes such titles as *Environmental Science: 49 Science Fair Projects, Botany: 49 More Science Fair Projects* and *Computers: 49 Science Fair Projects.* Each costs $9.95.
TAB/McGraw-Hill, Inc.
Blue Ridge Summit, PA 17294-0850
(800) 822-8138

Conserve and Renew is a new activity guide focusing on *conservation and renewable energy sources.* Includes 30 field-tested hands-on activities as well as teacher's background information, student handouts, a glossary and an annotated guide to energy education resources.

It is geared for ages 4-6, but is readily adaptable to other grade levels. Cost is $12.00.
SSU Academic Foundations
Conserve & Renew, Energy Center
Sonoma State University
Rohnert Park, CA 94928

An introduction to a new line of **science kits** by Edmund Scientific which can be assembled into actual working models, gives children a sense of accomplishment and greater understanding of the principles of science.There are five kits in the packet which costs $12.95.
Edmund Scientific
Dept. 11B1, Edscorp Bldg.
Barrington, NJ 08007

Science with a Pop is a free copy of a science sheet which describes popcorn science activities for the elementary level. Enclose a self addressed stamped #10 envelope. Dr. Donald A. Vannan
520 Crestwood Dr.
Bloomsburg, PA 17815

Experiments with Energy is a new resource for the middle school science curriculum. With this hands-on book students will learn about different types of *energy conduction* through classroom testing.These experiments are focused on topics such as solar energy and photosynthesis. A summary and instructor's guide are also included.
Channing L. Bete Co., Inc.
Attn: Sally W. Keir
200 State Road.
South Deerfield, MA 01373
(800) 628-7733.

Keep your Eye on the Ball: The Science and Folklore of Baseball applies physics to everyday life and scientifically tests some of baseball's myths. The book costs $12.95. Add $1.95 shipping and handling for first book, $1.25 for each additional book.
W.H. Freeman and Co.
4419 W. 1980
South Salt Lake City, UT 84104

The **Graphic Wizard** combines a ruler, circle and semi-circle templates, compass proctractor and T-square, angles, and more in one instrument. The tracking wheel allows all functions to be performed on glass, metal, wood and other smooth surfaces. Cost is $19.95.
The Wizard
883 Cape Haze Lane.
Naples, FL 33942
(800) 426-3555.

NAEP Mathematics Subscales and Math Learning Attitude Factors is a report of the U.S. Department of Education examining the relationship between student attitudes about math and their achievement levels. Cost is $1.50 for stock #065-000-00427-5.
U.S. Government Printing Office
Washington, DC 20402

Recommended Books of Science Activities is an annotated bibliography for elementary, middle school and high school libraries. Cost is $5.00.
Institute for Chemical Education
Dept. of Chemistry
University of Wisconsin-Madison
1101 University Ave.
Madison, WI 53706.

Color satellite-image map of **Antarctica,** 40x56 inches, for grade school through college. Cost $5.25 each plus $1. for each order under $10. Specify Map name and no. I-2284. Make checks payable to the Dept. of the Interior-USGS and send Map Sales,
U.S. Geological Survey
Box 25286, Federal Center
Denver, CO 80225.

ESTIMEASURING

Objective:
Students will perform basic data collection, measuring and estimation while exploring the concept of *average*. There are three types of averages - *mean*, *mode*, and *median*.

Materials:
- feet of students
- adding machine tape
- scissors
- rulers or tape measures
- paper; pencils
- clear tape

Procedure:

1. Have students estimate how many human feet are standing on the classroom floor. A later challenge would be to include the feet of tables and chairs. Record ways they estimated. This stimulates classroom discussion of estimation - the best guess. This record will be handy to refer to. How will you decide on the correct number?

2. Next divide the class into groups of four and have each group cut lengths of machine tape equal to the height of each member. Students should then measure the tapes and record individual heights in inches and centimeters on each tape.

3. Each group should tape their four measuring tapes together, end to end, and determine the total height. How would each group calculate its average height? One way is to fold the tape into four equal parts and measure one part. Another way is to divide the total height by 4, the number of members. Groups should then share their results and determine the average height in the class.

4. The three types of averages represent different ways to describe a group of objects. Average can mean different things to different people. The *mean* is determined by dividing the total cumulation of figures by the number of members (as in step #3). The *mode* is simply the most frequently occurring quantity or item. If more class members have blue eyes and there are six students with blue eyes the mode is 6. The *median* is the midpoint of the group of figures. Items must be arranged from highest to lowest. The middle is the midpoint. If there is an odd number of figures, the median is the exact middle. If there is an even number of items, the median is found by taking the two figures in the middle, adding them up, and dividing by 2.

5. Have students try this problem. Seven students recorded their ages on a chart. The ages were: 8, 8, 8, 9, 10, 12, and 15. One student said the average was 8 years, one said 9 years, a third said 10 years, and a fourth said from 9-12 years. How did these students arrive at those averages? Could their answers all be different ways of looking at average?

6. Students should construct a survey that attempts to describe the average student of a certain age or grade level using measurement. What characteristics will be investigated - arm span shoulder to fingertip? foot length heel to toe? hand span thumb to little finger? height head to toe? length of arm spread fingertip to fingertip with arms outstretched? Brainstorm ideas and then select five characteristics and design a method to measure the chosen group. Record, tally, and graph the results. How can the class determine a profile of the average student? Another graph might be done pictorially by outlining hands, heads, or feet and ordering them from largest to smallest.

7. Students might research the history of measurement - why standard measures are important; and the terms used to describe measurements such as handspan, or stone used in other areas of the world.

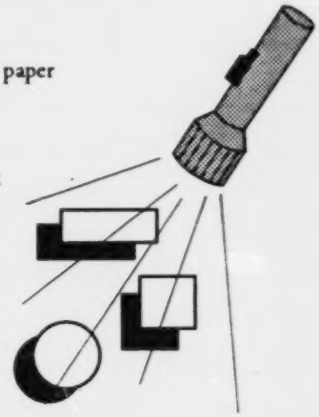
Adapted from *INSTRUCTOR MAGAZINE*. July/August, 1992; and *Pacific Science Center Activity Calendar*. Date unknown.

SHADOW MATH

Objective:
Students will observe and measure lengths and forms of shadows.

Materials:

- large mural or butcher paper
- masking tape
- measuring tools
- pencils; sidewalk chalk
- cardboard; scissors
- popsicle sticks
- clear day
- flashlight or bright lamp



Procedure

1. On a clear day in September place paper on the ground outside of the school in an area that will not be disturbed. Paper may have to be taped with masking tape. Students should work in partners to measure and record the lengths of each other's shadow every hour of one day from as early to as late as can be done. Make a graph of recorded lengths.

2. How do all the graphs compare? Which shadows were longest or shortest? Why did the shadow length change? Save the graphs and repeat the activity in the middle of March and the middle of June. How do the three graphs compare? A study of earth's rotation could be an extension of this activity.

3. Most students are familiar with the shapes of their own shadows, but many objects create shadows that can fool the eye. Try cutting a 2-3 inch square and circle from cardboard. Glue a popsicle stick to each shape.

4. Predict which of the following shadows can be made from the square or the circle. Draw the listed shapes so students can visualize what they are.

	CIRCLE	SQUARE
square		
line		
rectangle		
circle		
parallelogram		
trapezoid		
ellipse parabola		

5. If the cardboard or light source is moved, is the same shadow visible? Can students predict what will happen? What other shapes might be produced using the circle and square. What shadows would a rectangle or triangle produce. Try these shapes in the chart above.

6. What changes in shadow shape would occur using solid shapes? Construct a new chart for solid shapes, make predictions, and test them.

Adapted from *Pacific Science Center Activity Calendar.* Date unknown.

MOVING ALONG IN METRICS

Objective:

Students will begin to estimate and measure in metric terms. The activities will help students "think" in metrics. Students should practice using metric measurement in centimeters and meters prior to this activity.

Procedure:

Materials:

For pairs of students:

- **small toy cars with moving wheels**
- **chalk; pencil; paper**
- **meter sticks**
- **bare floor area**
- **Zoom/Metrics chart:**

ZOOM METRICS CHART				
Trip Number	Estimated Distance	Actual Distance	Difference Between Estimated & Actual Distance	Name of Better Estimator
1				
2				
3				
4				
5				
6				
Student's name _____			Total:	

1. Have students bring miniature cars, trucks, and vans to school for a Metric Rally. Cars should have moving wheels. Prepare a large uncarpeted area. Each student should have her or his own car to test.

2. Each pair should begin by marking a starting line on the floor with chalk. Students begin by rolling one car from the line using only one push. When it stops, leave the car in place but mark the area with chalk. Both students should estimate the distance without measuring. Then each student records his or her estimate in *metrics* in the proper column on the chart beside "Trip 1".

3. Then each student measures out his or her estimated distance using the meter stick and marks that distance with chalk. The car owner measures the exact distance and both students record that measurement under "Actual Distance - Trip 1". Both students should then find the difference between estimated and actual distance and record it.

4. The second student rolls her or his car for "Trip 2" and repeats the procedure until the charts are complete. Be sure the students understand that the object is not to go the farthest, *but to be the better estimator.* After the game is over, total the difference columns. The student with the smallest totals is a good estimator.

5. Estimation is making a mental picture of quantity. Did students refine their estimations after practicing with the game? Challenge the students further by calling out centimeter or meter amounts and having students place their hands the distance apart that they visualized. Are shorter or longer distances harder to estimate?

Adapted from *Mental Metrics.* National Science and Technology Week Activity Guide, 1987.

ASTROLABORATORY

Objective:

Students will construct an *astrolabe*, a device created by the ancient Greeks, used to determine positions of the sun and stars. It was later adopted to help early sailors determine their location at sea. The astrolabe determines *latitude*, position north or south of the equator.

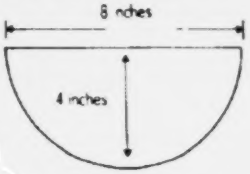
Materials:

For each astrolabe:

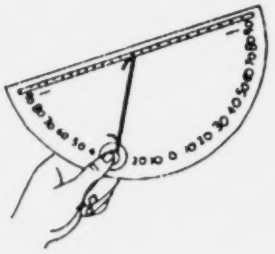
- cardboard
- scissors
- soda straws
- 12 inch piece of string
- metal washer
- protractor
- glue
- fine point marker
- world atlas

Procedure

1. Cut out a cardboard semicircle as shown. Using the protractor, turn the semicircle into a second protractor by copying the numbers and degree markings Do not write within the top 1/2 inch of the cardboard.



2. Tie one end of the string around the center of a straw. Then tie to washer to the other end of the string. Glue the straw just above the 90 degree marks, in the top 1/2 inch.
3. On a clear night, take the astrolabe outside. Face north (the sun sets in the west) and look for the two stars in the Big Dipper farthest from the handle. These point to Polaris, or North Star, the last star in the Little Dipper's handle.
4. Sight Polaris through one end of the straw. Without moving the straw, pinch the end of the string against the protractor, securing the washer at that point. Read the degrees indicated on the astrolabe. Use the atlas to determine approximate latitude. Compare the astrolabe reading and the latitude shown in the atlas.



5. Students may wish to research other early navigational instruments. Sailors used the stars and mathematics to travel the globe. How might better navigational tools have changed the history of sea travel? What about the possibilities for exploration?

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Copyright C 1991 Springhouse Corporation,1111 Bethlehem Pike Springhouse , PA 19477-0908 All rights reserved.

I TALK TO THE TREES

Objective:

Students will explore three ways to estimate or determine the height of a tree. The first two methods are rough estimates, the third method obtains a more exact measurement.

Materials:

- tree in school yard
- tape measures
- protractor
- paper; pencils

Procedure:

Students should work in pairs, reversing the roles of sighters and measurers.

1. *Between the Legs Method*

One student should bend over and look at the tree through his or her legs. The student should then walk away until he or she can see the top of the tree. The first student stands in place while the second student measures the distance from the base of the tree to the first student. This measurement equals the approximate height of the tree.

2. *Thumb Sighting Method*

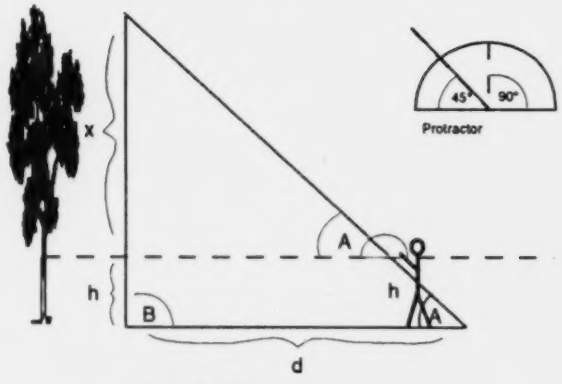
One student should hold up his or her thumb and walk backwards until the thumb and the tree appear to be the same height. That student should then turn the thumb parallel to the ground. Visualize two landmarks that appear to be the same distance apart as the length of the thumb. The second student measures this length, which is the approximate height of the tree.

3. *Protractor Method*

Students should construct a large cardboard protractor using a regular protractor as a guide. One student should sight the tree along the 45 degree angle of the protractor. and walk backwards until he or she can see the top of the tree.

4. The second student should measure the distance "D" from the base of the tree to first student's feet. This equals the tree height from the protractor level to the top of the tree. Add this to the first student's height to get the total tree height (X + H = D).

5. "D" is the height of this tree because all angles of a triangle total 180 degrees; angles A + B = 135 degrees, leaving 45 degrees for the remaining angle; and, if the angles are equal, the opposite sides must also be equal.



Angle A = 45%
Angle B = 90%
h= the height of protractor
d= distance from child to tree

Arlene Nichols. *Science is Elementary.* MITS, Inc.

I'LL SEE IT MY WAY

Objective:

Students will try to determine the actual shape of an object by exploring the variations in points of view when examining the same object from different reference points.

Materials:

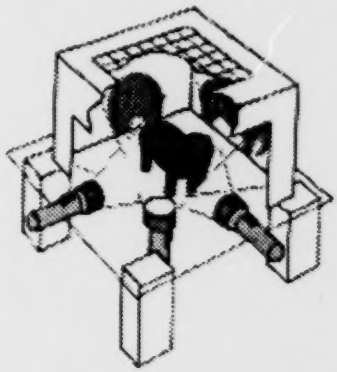
- cardboard box
- scissors
- tracing paper
- heavy clear plastic
- toy elephant
- books
- flashlight
- tape

Procedure:

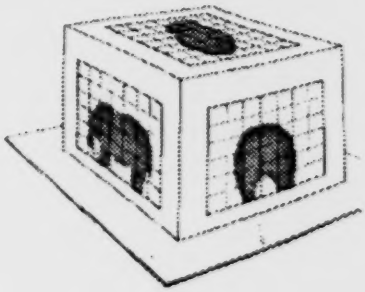
1. Construct the box by cutting the bottom off the cardboard box. Cut large holes out of the top and in two sides and tape tracing paper over the holes. Cut smaller holes in the other two sides. Cover the bottom with heavy, clear plastic.

2. Without showing anyone the object, place the toy elephant inside the box and then put the box on books as supports at the four corners so there is room for the flashlight to be held underneath. The flashlight should shine up through the bottom and cast a shadow of the elephant on the tracing paper. Shadows can be altered by changing the angle of the light.

3. Three students should sit on three different sides to observe and to sketch the shadows. Then the group should collaborate to determine just what the object is. An extension would be to have them construct the object



4. Check if the object made is correct by placing it in a second box and comparing the shadows of the construction to the original object. How hard is it to determine the object? How many angles are necessary to make a correct determination? What if an object were placed in the box upside down?



Adapted from *The National Elementary Principal.* January/February 1974.

SKITTLE DE DO

Objective:

Students will review concrete, picture, bar, and line graphs; and interpret and make circle graphs. Their explorations integrate statistics, probability, measurement, and geometry.

Materials:

- Skittles candy, or any small candy in an assortment of colors
- worksheet
- record sheet
- bar and line graph
- circle graph
- graph paper
- "post-it" notes
- red, green, purple, yellow, orange crayons – colors to match candies
- markers
- protractors; compasses
- lined chart paper; drawing paper
- stapler
- calculator

Procedure:

1. Randomly distribute 36 candies to groups of students. Groups should then place them on the worksheet to make a concrete graph. Then students should color in the circles under each candy to make a representational picture graph.

2. Tally the candies by color on the record sheet. Groups should use that data to construct a bar graph by shading in the squares on the two columns above the color name. Construct a line graph over the bar graph by connecting the midpoints of the shaded bar graph with a marker.

3. Use the 36 section circle graph to shade in the appropriate number of sections for each candy color. Ask students to list the colors as fractions (purple is 4/36 for example). Use a calculator to convert the fractions to percents as an extension activity.

4. Display the graphs. Why are some colors more prevalent than others? Can an average color be determined? Generate and answer questions about the results. Student groups should record a list of true statements about the information represented on their graphs.

5. Next give each student a "post-it" note and ask them to record their favorite candy color on it. Place the notes in a central location to make a bar graph for the class.

6. Using a strip of lined chart paper, students should mark off the number of squares to match each color receiving class votes. Loop the strip around and staple the ends. Then place the stapled strip on drawing paper and trace around the circle.

7. Students should then use the markings on the strip to record the colored sections onto the circle. Draw lines from the markings at the edge of the circle to the center of the circle making wedges of varying sizes. This is an approximate representative circle graph of the class choices.

8. Use the calculator to convert the fractions to percents. Try to convert the percents to degrees, reviewing 360 degrees in a circle (0.30 x 360 = 180 degrees). Then use a compass to draw a circle on a second paper and mark one radius. Use that radius and the center of the circle, students should use the protractor to make angles that match the number of degrees for each color.

9. Compare the two circle graphs. Who might need thiskind of information? What are other ways manufacturers might determine product popularity?

Adapted from *The Elementary Mathematician.* Volume 6, No. 2, Late Summer 1992, published by Consortium for Mathematics and Its Applications (COMAP), 57 Bedford St., Suite 210, Lexington, MA 02173.

Skittles® Worksheet

Red ○○○○○○○○○○○○○

Yellow ○○○○○○○○○○○○○

Orange ○○○○○○○○○○○○○

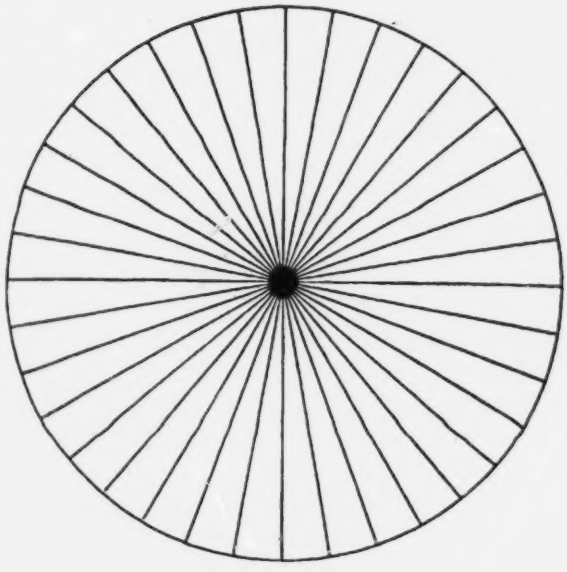
Green ○○○○○○○○○○○○○

Purple ○○○○○○○○○○○○○

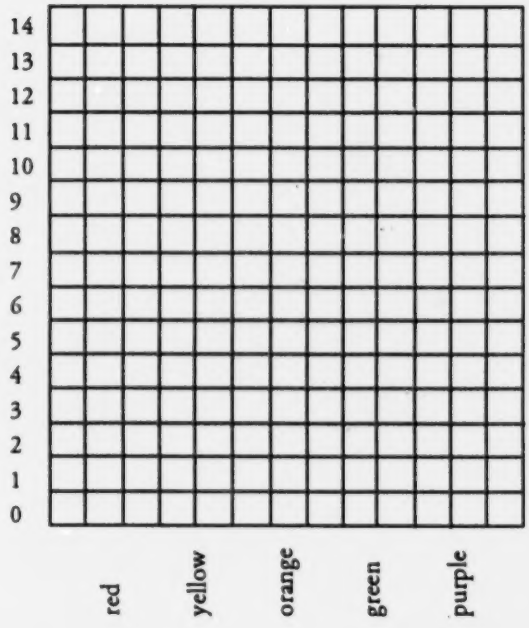
Skittles® Record Sheet

COLOR	TALLY	TOTAL
Total		

Skittles® Circle Graph



Skittles® Bar and Line Graph



THE SCIENCE OF CONSTRUCTION

Objective:

Students will explore various architectural structural designs to build a bridge, a skyscraper, and a dome. These particular designs involve two important questions: what building materials are available? how can a structure be designed so that it will work using those materials?

Materials:

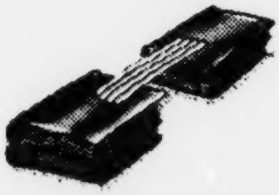
- sheets of typing paper cut in half lengthwise
- two stacks of books equal in height (10 cm)
- scissors; glue
- metric ruler
- 40-50 pennies
- 7-oz plastic cups
- 4 egg shell halves
- 20 cm x 20 cm piece stiff cardboard
- magazines
- paper towels; newspapers
- papier maché paste
- small, round balloons
- bowl; spoon
- cardboard box
- cookie sheet
- 10 lb bag potatoes
- 60 flexible plastic straws

Procedure:

1. Bridges

Students will explore various bridge designs. Set up the two stacks of books to equal heights. Lay a flat piece of typing paper between the books and begin placing pennies, one at a time, in the middle of the bridge. How strong is it? Cut the paper in half lengthwise and lay a double sheet across the books. Is this stronger?

2. Fold a piece of paper lengthwise and test with pennies. Results? Now try folding the paper as an accordion shape lengthwise. Test this design's strength. Might the number and size of the folds affect the strength? Try it. This would be a hard design to drive over!



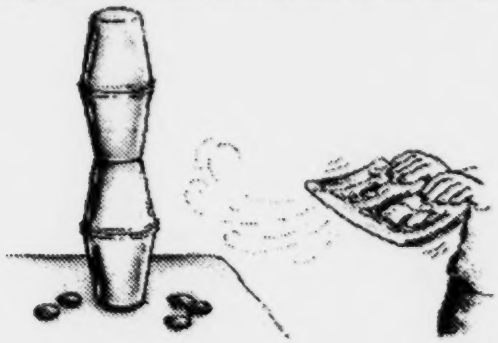
3. Cut a paper in half lengthwise and place one strip between the book stacks to make an arch, the same height as the books. Place the second strip over the arch between the books. Does this design strengthen the bridge? Lastly, try folding each long side of the paper up so that the bridge has walls on both long sides. Test this bridge. Does a change in the size of the walls affect the strength?

4. Students should graph the results of all tests and decide which design has the most promise. Then, each student should try to design a bridge that can hold the most pennies. **Rules:** A) the bridge can be made from only 1/2 sheet of paper (use less if desired, but not more). B) no glue, tape, or other material can be used. C) paper may be folded or cut any way. D) the two stacks of books used must be at least 10 cm high and 12 cm apart.

5. After this part of the project is completed, research and find pictures of actual bridges, both ancient and modern. What patterns or relationships become visible? Can students build better bridges using straws or toothpicks? Do any natural bridge shapes (not man-made) occur in nature?

6. Skyscrapers

Students will try to build the tallest skyscraper that will withstand a windstorm. Using a very thin layer of glue around the rims of the plastic cups, build a 4-cup building as shown. Stand 1 meter from the building and wave a single magazine in front of the building creating wind. Hypothesize how tall a structure can be built this way.

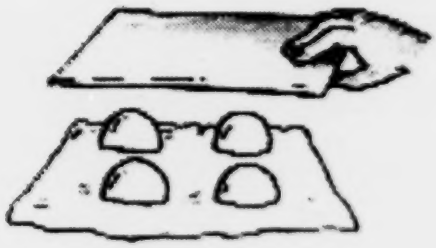


7. If the skyscraper is still standing, add more cups to make it taller. Test after each addition. How tall can the building be before it falls over? Try filling the bottom of the skyscraper with 40-50 pennies. Does this add support? How high can the building be with the extra support? Students should graph all results.

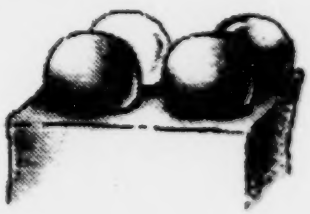
8. After this part of the project is completed, students should research and find pictures of famous skyscrapers. What is the tallest building in the world? Where did the term "skyscraper" originate. Can students design another type of skyscraper? Do any natural skyscrapers (not man-made) exist?

9. Domes

One of the strongest shapes is the dome. Start by placing a paper towel on a table and arranging the 4 egg shells in a square. Place the cardboard on top of the shells so the cardboard sticks out 3 cm past each dome. Hypothesize how many magazines will be supported by the shells, then place magazines one by one on the cardboard. Keep stacking until you hear cracking! Why might the dome be a good shape for eggs?



10. Next create papier mache domes for further explorations. Cut four holes in the bottom of a cardboard box. Blow up and tie the balloons, and place them in the holes with their rounded sides sticking up above the box. Using papier mache paste and strips of paper towelling, lay strips across balloons so that the center of each strip crosses the center of a balloon. Cross four strips over each balloon so that the top and sides are completely covered. Mold smooth dome shapes and let dry THREE (3) DAYS.

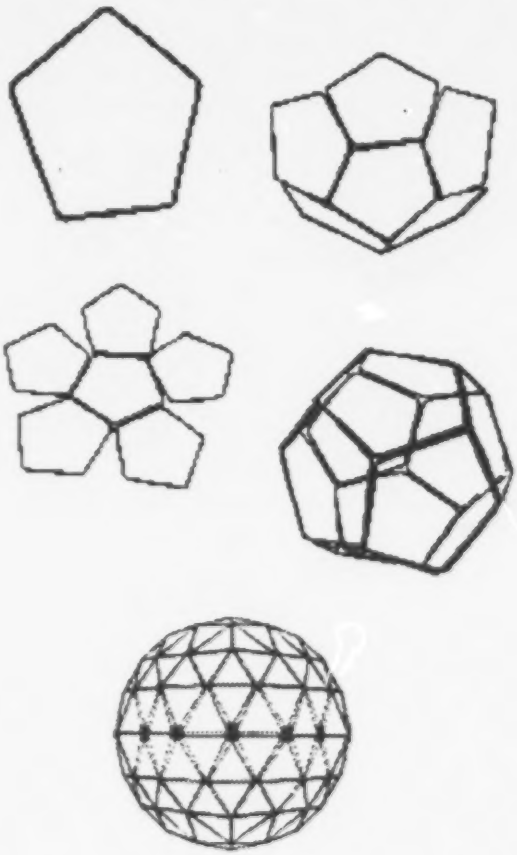


11. When the domes are dry, pop the balloon and trim the dome's edges so that it will sit on a table evenly. Place domes on a newspaper in the same arrangement as the egg shells with the cookie sheet over them. Place 4 books on the domes. Do they crack? Remove the books and place the bag of potatoes on the domes. If they still do not crack, have the smallest student take off his or her shoes and try standing on the domes. *Always hold an adult's hand when doing this.* If certain domes break it is because they are weak in an area. Experiment with domes until they are with-Standable! Graph all results.

12. The geodesic dome is the world's strongest known structure. It was invented by Buckminster Fuller, the American architect. These domes can be quickly assembled and dismantled. Students can assemble their own dome using the 60 flexible drinking straws. When putting straws together be sure to insert the long end of one into the short end of another, completely up to the bend. Most geodesic domes are constructed from hexagons (six-sided figures). Students will use pentagons (five-sided figures) to make a model.

13. The basic shape is a pentagon. Connect five straws into a pentagon, with the flexible joints as the corners. Make eleven more pentagons the same size. Place one pentagon in the center of the table and the others around it as shown. Lift the surrounding pentagons so their sides touch and tape these sides together. This is one half of the dome. Construct the other half in like manner. Tape the two halves together to complete the dome. What tests can be devised to test the dome's strength?

14. After this part of the project is completed students should research and find pictures of famous ancient and modern domes. What examples of domes can be found in nature? With examples of all three structural designs, both man-made and from nature, can students design a building incorporating them all? Would you want or need to do this? Why are specific structural designs better for some areas or types of building materials than others? How are beaver dams, spider webs, and ant hills constructed?



Adapted from *WONDERSCIENCE*, The American Chemical Society. February 1991.

THE SCIENCE OF HURRICANES

Objective:
Students will use a chart to track the progress of a hurricane simulation. The chart can also be used to track real hurricanes from weather forecasts. The chart is reprinted from the *National Oceanic and Atmospheric Administration's* NOAA/PA 77020, March 1982.

Materials:
- reprints of tracking chart
- hurricane report
- colored pencils
- political map of United States and Caribbean showing latitude/longitude

Procedure:
1. Copy tracking chart, and map for pairs of students. Make the tracking reports into cards to represent individual reports. Review simple map-reading skills.
2. Explain basic information about hurricane characteristics:
   - gain speed and energy moving over tropical waters
   - lose speed and energy moving over land
   - warm body of water can alter hurricane's direction and energy
   - winds generally extend 60 miles out from eye of storm
   - South Atlantic hurricanes originate near the equator and tend to move west
3. Locate and label Caribbean islands, Southeastern states, and a few major cities in both areas. Students are now meteorologists receiving hurricane reports based on satellite and air observations. Students will plot report time and the hurricane's direction using colored pencils. Students will then draw a dotted line in the direction they "think" the hurricane will go, before the next report comes in, based on all the information they have. Reports should be distributed every 8-10 minutes.
4. Students should issue watches and warnings when they feel it is necessary. Most areas require 6-12 hours for evacuation. A hurricane warning should include:
   - hurricane name
   - time and date of warning
   - name of meteorologist
   - major residential areas affected
   - estimated time of hurricane's landfall
   - potential winds and rainfall estimates

5. *Fictitious Report*

HURRICANE MITS Advisory
National Weather Service
Frank Gardner, Meteorologist
9:00 P.M. AST Mon., Sep. 18, 1989

...Hurricane Mits is nearing the eastern tip of Caribe Island. The government of Caribe has issued a hurricane warning for eastern Caribe effective 9:00 A.M. Sep. 19, 1989 Atlantic Standard Time. Mits has been wobbling but generally moving towards the northwest near 10 miles per hour. All residents should proceed immediately to designated shelters.

The center of the hurricane threatens to move over the island bringing in the storm's full force. The slow, erratic movement is expected to continue prolonging the heavy rains. Residents of Caribe should be advised that landfall over the next six hours will bring heavy rains, flooding, mudslides, and sustained winds of 110 mph.

The next hurricane advisory report will be issued at 3:00 A.M. AST.

6. *HURRICANE TRACKING CHART* (make into cards).

A) 09/18/89-3:23 a.m.
Center located 17N latitude/64W longitude
Winds 120 kilometers, gusts 140 kph
Flooding 4-8 feet above normal
Rainfall 10 inches in hurricane path

B) 09/19/89-4:55 p.m.
Center located 18N/66W
Winds 110 kph, gusts 130 kph
Flooding 4-6 feet above normal
Rainfall 15 inches in hurricane's path

C) 09/19/89-10:18 p.m.
Center 19N/67W
Winds 100 kph, gusts 120 kph
Flooding 4-6 feet above tide levels
Rainfall 10 inches in path

D) 09/19/89-3:45 a.m.
Center 20N/67W
Winds 95 kph, gusts 110 kph
Flooding 4-6 feet above tide levels
Rainfall 10 inches in path

E) 09/20/89-3:35 p.m.
Center 24N/70W
Winds 90 kph, gusts 105 kph

F) 09/20/89-3:59 p.m.
Center 25N/71W
Winds 90 kph, gusts 105 kph

G) 09/20/89-10:06 p.m
Center 27N/73W
Winds 90 kph, gusts 105 kph

H) 09/21/89-3:39 a.m.
Center 28N/74W
Winds 95 kph, gusts 110 kph

I) Center 29N/76W
Winds 95 kph, gusts 110 kph
Rainfall 10 inches in path
Flooding 8-12 feet above tide levels

J) Center 30N/78W
Winds 100 kph, gusts 130 kph
Rainfall 10 inches in path
Flooding 10-15 feet above tide levels

K) 09/21/89-9:58 p.m.
Center 31N/78W
Winds 120 kph, gusts 140 kph
Rainfall 10 inches in path
Flooding 12-17 feet above tide level

L) 09/22/89-3:42 a.m.
Center 32N/80W
Center 31N/78W
Winds 60 kph, gusts 75 kph
Rainfall 10 inches in path
Flooding 12-17 feet above tide level

7. At the conclusion of the activity pairs should compare their predications and maps. How does this simulate various weather forecasting agencies? Are reports always similar? Why might they vary so much? At what point did it become difficult to track the hurricane? Why did the hurricane change direction? What areas might be evacuated unnecessarily? What areas might be endangered but not evacuated? Do students know correct evacuation procedures? Create an evacuation plan for the school.

HURRICANE TRACKING CHART

REMEMBER: hurricanes are large powerful storms that can suddenly change direction. Check frequently on the storm's progress until all Watches and Warnings for your area from the National Weather Service are canceled.

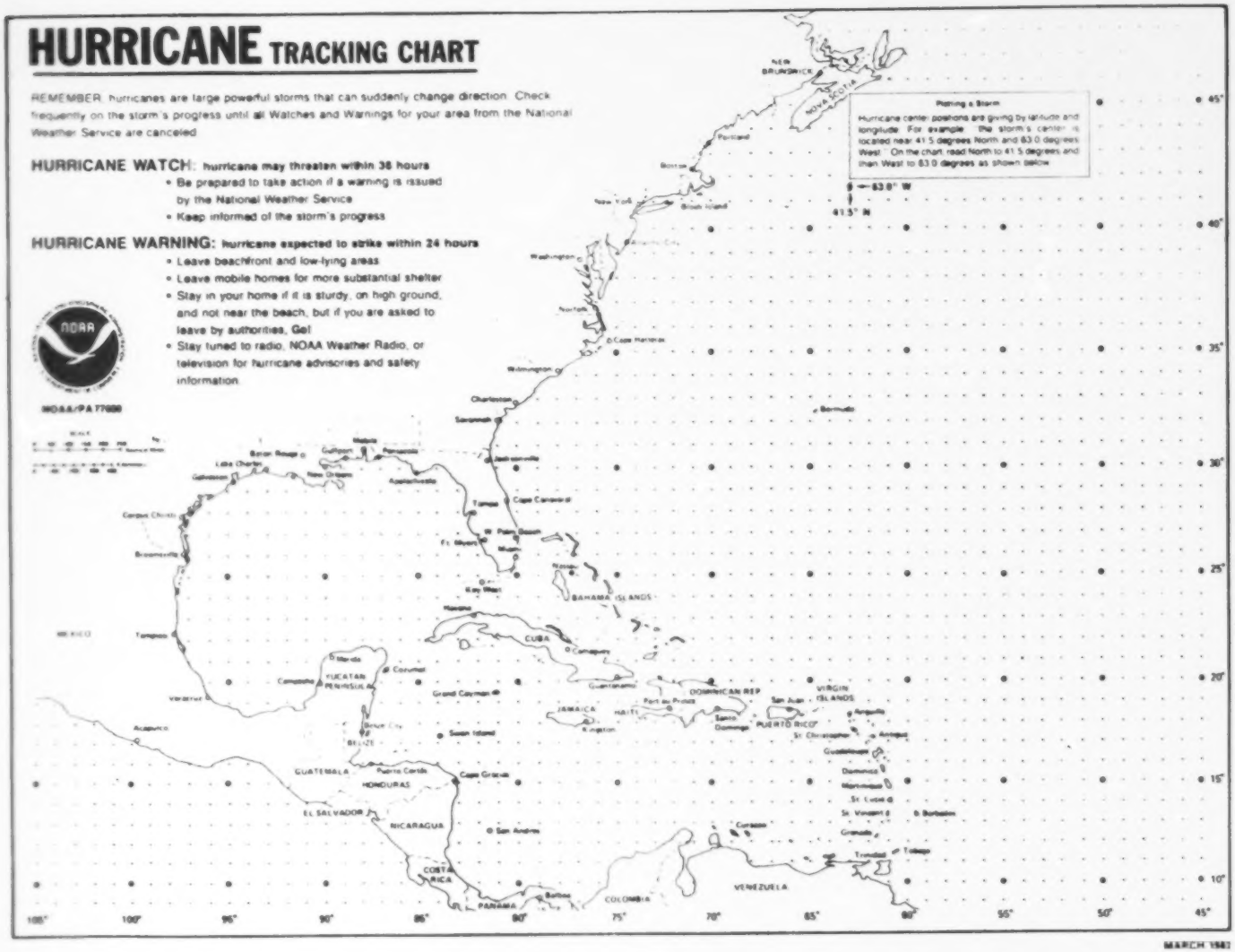
HURRICANE WATCH: hurricane may threaten within 36 hours

- Be prepared to take action if a warning is issued by the National Weather Service
- Keep informed of the storm's progress

HURRICANE WARNING: hurricane expected to strike within 24 hours

- Leave beachfront and low-lying areas
- Leave mobile homes for more substantial shelter
- Stay in your home if it is sturdy, on high ground, and not near the beach, but if you are asked to leave by authorities, Go!
- Stay tuned to radio, NOAA Weather Radio, or television for hurricane advisories and safety information.

NOAA/PA 77008



MARCH 1981

Adapted from *Tracking a Hurricane-On the Frontier of Weather Forecasting.* National Science and Technology Week Activity Guide, 1991.

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Tropical Rainforests

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'78

Mission • *Science is* ELEMENTARY

The Museum Institute for Teaching Science was started in 1983 as a collaboration of seven (then eleven) museums across Massachusetts for the purpose of increasing and improving the teaching of science in elementary and middle schools. From 1986-1991 under the leadership of Frank Gardner, Executive Director of MITS, a series of successful workshops were presented and the resource publication for teachers, *Science is Elementary*, was developed. These activities were funded by the National Science Foundation, the federal Department of Education and private foundations and corporations. Early in 1992, the directors of the collaborating museums advised that it was time for MITS, Inc. to become a separate entity.

MITS, Inc. was incorporated in June of 1992. The purpose remains: the teaching of participatory, inquiry-based science, math and technology in elementary and middle schools. This goal is achieved by promoting cooperative ventures between institutions of higher learning, museums, businesses, federal and state agencies, and schools. These ventures include workshops, conferences, and a resource publication to promote continuing professional development for teachers, museum educators and school administrators.

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Brief Brief

We apologize for getting this issue of SIE to you so late in the school year. As you know, Beverly Maffei, our talented editor, was designated the Elementary Science Awardee for Massachusetts of the Presidential Award for Excellence in Teaching Science and Mathematics. Obligations and requests devolving from this honor made it impossible to publish SIE on our original timetable. We have also found Constance Gavin to help with the production. There is a great deal of attention being focused on the tropical rain forests. We hope that SIE will bring you background information and activities to help your students understand where the tropical rain forests are located, what they are, what is happening to them, and why it may be important to preserve them. In working with your students always integrate a variety of curriculum areas. The topic of rain forests lends itself well to art, math, language, and social studies activities. Many of the problems associated with manipulating the forests of the tropics apply to the forests of Maine, the northwestern United States, Hawaii and even the vacant lot, park or swampy area near your school or home.

The *Water Planet*, our next issue, will show the importance of water to all life on Earth. Enjoy this issue and send us your comments and ideas. If you have any successful activities you would like to share, please send them along.

One of the tricks that museums use in designing exhibits is to **make big things little and little things big**. Teachers use that same trick when designing interactive bulletin boards. Because most students will never experience a rainforest personally, this issue's Trade Secret demonstrates how to build **personal rainforest terrariums**, allowing students to make first-hand observations of simulated mini-environments. In this process, students will create a self-sustaining, miniature ecosystem and explore the principles and processes that occur in ecosystems. There are many possible variations that students can observe and experiment with in order to find out more about rainforest ecosystems.

This rainforest terrarium model, developed at the New England Aquarium, should require little care. It will need sunlight, the **energy source** that will allow the plants to take in carbon dioxide for growth and production of oxygen. The system will need a source of **nitrogen.** If animals such as worms or insects are not present in the "forest", add a little bit of fertilizer for the nitrogen. If there will be animals, pick appropriate species such as plant-eating insects. Balance the presence of plant-eaters by introducing insects or other small animals that consume plant-eaters. The ecosystem will also need decomposers to recycle dead leaf matter into the soil. Topsoil in the system should have a sufficient supply of bacteria and fungi to act as **decomposers.** Otherwise, introduce a small, decomposing piece of tree branch.

The terrarium may be constructed in a large classroom aquarium, or individual students can maintain their own aquariums by constructing them in two or three liter-sized soda bottles. Make the choice before gathering materials.

Materials

Choose the type of container before starting:

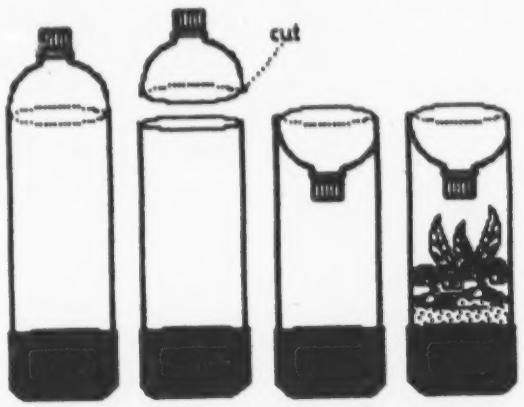
- 2 or 3 liter clear plastic soda bottles, 1 per student.
- A single aquarium with a plexiglass lid

Then collect the following:

- gardening charcoal
- sand or aquarium gravel
- small rocks
- small, plastic container for water
- rich potting soil or topsoil
- cellophane or masking tape
- water
- plants and animals

Set-up

Choose a container as previously mentioned. If individual soda bottles are used, prepare them as shown in the diagram. Then, for either container type pour about two inches of loose sand to cover the bottom of the container. Cover the sand with a thin layer of planting charcoal or gravel. These are available at garden supply departments or nurseries. Cover the charcoal layer with 2 inches of potting or topsoil. Place some rocks and a water container such as a jar lid, into the soil.



Plant chosen tropical plants in the soil. They should be placed in small, individual, pre-moistened holes, with growth space between them. Plants vary in Asian, African, and American rainforests. It might be interesting to design containers representing each type to compare their growth. Water the plants sufficiently to insure that they are in moist (not soggy) soil. Troipcal plants may be obtained from an aquarium pet store. Rain forest plants may be obtained from a local nursery. Use any of the following: Anthirinum, Deffenbachia, Schefflera, Dracaena, Philodendron, ferns, liverworts, mosses, prayer plants, and bromeliads. Cover the top of the aquarium container with a sheet of plexiglass. This can be measured and cut at a hardware store or glass supply store. Cover individual soda bottles with clear tape. Make a nearly airtight seal. Place the rainforest where it will receive morning sunlight, but avoid extremes in temperature. Water should recycle naturally in this closed system. Evaporation and transpiration will provide condensation at the top, forming droplets, which will rain down on the ecosystem below. If the system seems too dry, add a little water. If it is too wet, open the top a crack.

There are many observations to be made. Students can study the hydrologic cycle, the movement of water through the rain forest. They can develop field guides of the plants and animals present so outside observers can identify species, or chart plant growth on a weekly basis. Students should also develop a set of questions they would like to answer about this fertile environment. Can they "build a better rain forest?" Why can't students see all the animals all of the time? What changes take place over time and why do these changes occur?

Sample questions

•Is there more condensation on one side than on the other? Is this related to the number of plants or to differences in sunlight? How can you find out? How could students measure the amount of condensation on the terrarium lid each day?

•What kinds and how many types of animals could live in this small rain forest? How can students design an experiment to find out?

•Do some plants or animals tend to dominate or crowd out others? How many species can survive in the ecosystem? How can students design an experiment to find out?

•Is the terrarium temperature the same as room temperature? Why? Chart the temperatures.

Rain forests are stable ecosystems and have existed in their present form for almost one hundred million years. Read the In The Know section for more information on rain forests. For an extended project, consider grouping students by ecosystem and building terrariums for a salt marsh, a desert, or a grassland. Then the ecosystems could be compared for temperature, water use, plants, and animals.

An Adventure in the Amazon. Cousteau Society. Simon and Schuster, 1992. Grades 3-8. Introduces the reader to tropical forest species and the unique physical and cultural characteristics of the region. An outstanding presentation with age appropriate comparisons for understanding economic and social problems leading to destruction of the forests.

Journey of the Red-Eyed Tree Frog. Tanis Jordan. Simon and Schuster, 1991. Grades K-4. Fiction that reveals the plight of South American forest species resulting from the encroachment of humans. An important ecological story.

Amazon: A Young Readers Look at the Last Frontier. Peter Lourie. Caroline House, 1991. Grades 4 and up. Summarizes the main ecological problems facing the Amazon region today.

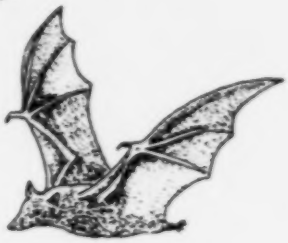
Chameleons: Dragons in the Trees. James Martin. Crown, 1991. Grades 1-5. Introduces the world of chameleons. Includes an index.

Living Treasure: Saving Earth's Threatened Biodiversity. Laurence Pringle. Morrow, 1991. Grades 3 and up. Provides the reader with information necessary to understand environmental changes. Examines variety and diversity and explains natural selection, genetic variation and evolution. Glossary and index included.

At Home in the Rain Forest. Diane Willow. Charlesbridge, 1991. Grades K-3. An introductory book on the plants and animals of the Amazonian rain forest. Emphasizes the connections that link species at all levels of the forest. Illustrations are outstanding.

Jungle Rescue: Saving the New World Tropical Rain Forests. Christina Miller and Louise Berry. Atheneum, 1991. Grades 4-8. Presents rain forests in general and northern hemisphere forests in particular. Explains what a rain forest is and compares it to other types. Activities are integrated into the text. Lists additional resources and provides a reading list and index.

Animal Camouflage: A Closer Look. Joyce Powzyk. Bradbury, 1990. Grades 3-8. Explains concealing coloration, disruptive coloration, disguise, mimicry and masking as methods of camouflage. Information on the animals featured is provided. Glossary, index, and bibliography.



Bats. Sharon and Susan Shebar. Watts, 1990. Grades 4-7. Dispels myths about the only flying mammal. Explains species, echolocation, migration, hibernation, reproduction and place in the ecosystem. Glossary, index and bibliography.

The Great Kapok Tree: A Tale of the Amazon Rain Forest. Grades K-6. Lynne Cherry. Gulliver, 1990. Animals argue against chopping down the Kapok tree, explaining how each depends on it for home. Examines the interdependence of living things.

One Day in the Tropical Rain Forest. Jean Craighead George. HarperCollins, 1990. Grades 3-6. The struggle between developers and conservationists over the rain forest is observed by an Indian boy. Details the complexity and interdependence of the flora and fauna. Index and bibliography.

The Emerald Realm. National Geographic Society, 1990. Grades 5 and up. Provides a comprehensive view of the rain forest habitat and its complex problems. Pictures and text are extremely informative.

Tropical Rain Forests Around the World. Elaine Landau. Watts, 1990. Grades 4-8. Presents a readable overview of these fragile treasures. Explains particular species, their interrelationships and their problems. Details human impacts. Includes a map showing forest locations, glossary, index and bibliography.

Journey Through a Tropical Jungle. Adrian Forsyth. Simon and Schuster, 1989. Grades 4-8. A biologist-writer-photographer chronicles several weeks in the Monteverde Cloud Forest Reserve of Costa Rica. Index.

A Neotropical Companion. J.C. Kricher. Princeton, 1989. Adult. Background information on the rain forest and its creatures. Good for research.

Rain Forest. Helen Cowcher. Farrar, 1988. Grades K-2. A simple tale about the threat to the planet's rain forests and the variety of species that inhabit them. Available in Big Book format from Scholastic.

Where the Forest Meets the Sea. Jeannie Baker. Greenwillow, 1988. Grades 1-4. A boy ventures between two ecosystems. Introduces Australia's primeval forests. Available in Big Book format from Scholastic.

The Enchanted Canopy: Secrets from the Rainforest Roof. Andrew Michell. Collins, 1986. Adult. Presents a detailed overview useful for background information.

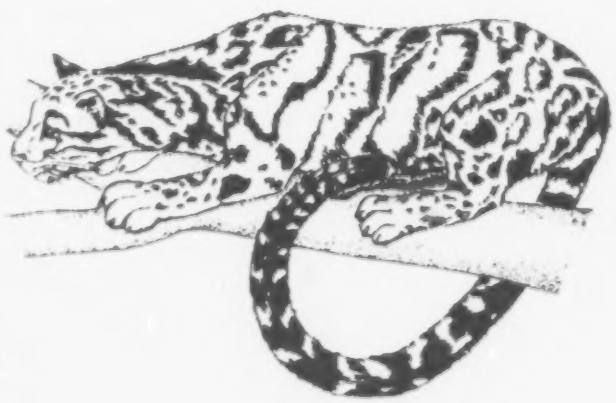
Rainforest Homes. Althea. Cambridge U. Press, 1985. Grades 1-6. Presents an overview of rainforest habitats.

A Walk in the Rain Forest. Kristin Joy Pratt. Down Publication. Nevada City, CA, 1992. Written and illustrated by a 15 year old.

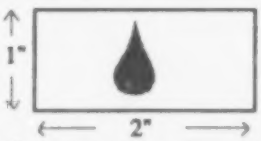
At Home in the Rain Forest. Diane Willow. Charlesbridge Publishing. Watertown, MA, 02172. A colorful introduction to plants and animals of the rain forest, written by the Boston Children's Museum education director.

Save My Rain Forest. Monicae Zak, Volcarce Press, Volcanoe, CA, 1992. A young boy wants to save the rain forest and embarks on an adventure.

Rainforest Secrets. Arthur Dorres, Scholastic Inc., NY, 1990. An informative introduction for young readers.



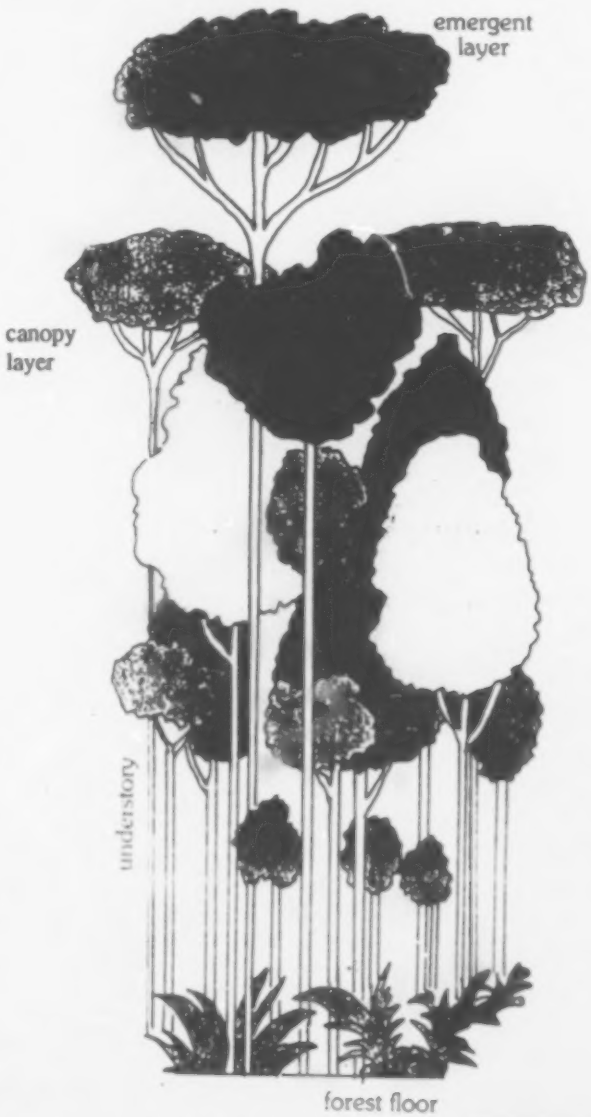
Tropical Rain Forests are the oldest, most biologically diverse, and most threatened natural communities on Earth. They are found on all continents except Europe and Antarctica. They are characterized by hot, humid weather all year. Temperatures average 70-85 degrees. Tropical rain forests get more than 60 inches of rain a year, although some areas regularly get more than 200 inches, and other areas get more then 400 inches. It's easy to demonstrate how much rain that is by making a rain drop tape measure. Reproduce the inch "drop pattern" and cut and tape pieces together to make a 400 inch tape measure. Compare student heights to 60", 250", and 400". Compare tropical rain forest measures to average rainfall in your area. This information is available on weather maps or from the weather service. In the rain forests of South America, scientists estimate that as much as 250 billion tons of water vapor can be suspended in the air over the forests at any one time. Rain forest humidity is 70% during the day and 95% at night. This characteristic humidity results from the consistently high temperatures and abundant rainfall.



inch drop pattern *(enlarge)*

Rain forests are only one type of tropical forest. The others are *tropical seasonal forests* and *tropical cloud forests*. Seasonal forests have two distinct wet and dry seasons. Cloud forests grow at elevations higher than rain forests, and are denser. Cloud forests have shorter trees and are relatively cool.

Rain forest soils support incredible plant diversity although the soil is not fertile. Most of the nutrients that plants need are stored in the plants themselves. The lack of nutrients results from the massive rainfall and the age of these forests. Rain leaches nutrients from soil. In rain forests, that leaching is constant and has been occurring for millions of years. Roots of rain forest trees have adapted to the conditions by staying near the surface so that nutrients available (usually from decaying animals and plant matter on the forest floor) are immediately utilized. Billions of microorganisms that live in the soil help break down debris quickly into usable nutrients. This continual, constant recycling of nutrients keeps rain forests working efficiently.



Rain forest plants form a complex system of layers. **The Emergent Layer** consists of giant trees called *emergents*. These can reach 115-250 feet high. There are usually only one or two of these trees per acre. They have small leaves, umbrella-shaped crowns, and tall, slender trunks. Emergents endure high temperatures, low humidity, and strong winds. Some emergent species have buttress roots and others have stilt roots.

The Canopy Layer consists of flat-crowned trees 65-100 feet above the ground. These trees are also subjected to changing temperatures and humidity. The canopy trees form a continuous covering that acts as a giant sun/rain umbrella, allowing only 2%-5% of either to slip through to the forest floor. This layer also absorbs much of the rain's impact. Leaves of canopy trees are pointed to allow more water run-off. Roots are buttressed or stilted. The canopy is home to many creatures and plants.

The Understory Layer consists of smaller trees only growing to 15 feet, and a shrub layer of young canopy trees. These trees have elongated crowns shaped like flames, and many have large leaves to absorb maximum sunlight. This layer is always dim.

The Forest Floor Layer consists of sparse vegetation, still air, and 70% humidity. The temperature remains constant. The rain forest floor is relatively open, contrary to the concept of "jungle" which conjures visions of dense undergrowth.

Although rain forests cover less than 7% of the Earth's surface, they are estimated to be home to more than 50% of all species on Earth. The figure could actually be higher as new species are constantly being discovered. This biodiversity is due to the age of the forests (tens of millions of years), and on-going climatic changes. The constant warmth, sunlight, and humidity make it possible for a variety of plant species to thrive. The abundant rain forest growth creates niches where many animal species can live. The majority of species in rain forests are rare. There are many types of species, but very few individuals. Scientists think this natural scarcity is due to the high number of separate species inhabiting forests, and to the high degree of specialization they have achieved.

Many plant species have developed special survival strategies for the unique rain forest conditions. Some plants grow on top of other plants to get "closer" to sunlight. Ferns, mosses, orchids, and bromeliads have adapted that strategy. Climbing vines creep straight up trees toward the light. Many trees grow very slowly taking over space vacated by dying trees. Some seeds lay dormant for years and then suddenly sprout and quickly grow to fill gaps that appear. Other plants store water in their stems or have aerial roots (roots above ground) that absorb moisture directly from the air. Plants have also developed distasteful chemicals in their leaves, or sharp spines to keep animals away. Sheer size is also an adaptation to the conditions. Violets can grow to 30 feet tall and water lillies to 7 feet across.

Rain forest animals have also developed survival strategies for finding living space, food, mates, and for avoiding enemies. Animals inhabit specific layers of the forest. Toucans and hornbills nest in the tallest

trees, while deer stay on the forest floor. Coatis roam between layers. Other species feed only on specific types of food or eat at specific times. Colobus monkeys and pottos feed in the treetops, but pottos eat at night and monkeys eat during the day. Camouflage strategies are striking in the rain forest. One praying mantis looks like the petals of an orchid, and some caterpillars look like bird droppings. Most animals use sound to communicate as distances between individuals of a certain species are vast.

There are also unique plant/animal partnerships in the rain forest. The majority of rain forest plants depend on animals for pollination. Insects, bats, and birds are the most common pollinators. Many plants have exclusive pollination partnerships. Each of the more than 900 species of fig trees around the world is pollinated by a different species of fig wasp. Most rain forest plants rely on animals to disperse their seeds as well. Seeds are encased in fruits that attract and are ingested by animals. Seeds are regurgitated or passed as the animals move to new locations. These intricate and complex relationships contribute the fragility of rain forests. The removal of just one species can effect many others.

The Maya culture flourished in rain forests for 600 years. Over 1000 tribes still call rain forests home. These peoples have developed their own partnerships with the forests, and the small number of individuals in each tribe makes their use of the rain forests sustainable. Farmers use slash-and-burn agriculture techniques conservatively. They farm small plots for years and then allow those fields to lay fallow for up to 20 years. They then burn a new area. By the time they return to the first plot it has reverted to forest and nutrients have accumulated. The "new settlers" clear large areas and do not let fields lie fallow, having impact on the forest. Other tribes are hunter-gatherers and forests can easily accomodate their needs. Forest dwellers hunt, fish, or farm to sell goods to outsiders. Bananas and coffee are cash crops. We can learn much from indigenous rain forest peoples. Their shamans represent collective storehouses of botanical knowledge. The forest diversity has provided and should continue to provide medicines, foods, and other products. Over one quarter of medicinals used in America are derived from rain forest plants. The Rosy Periwinkle of Madagascar contains alkaloids that have revolutionized the treatment of leukemia and Hodgkin's disease. Of plants identified as having anticancer properties, 70% occur in tropical rain forests. Who knows what has not been discovered as yet? In addition, Latin American forests are habitat for many of the U.S. 's migratory birds. A square mile of Costa Rican rainforest has been found to contain 269 bird species, more than wildlife-rich Alaska, an area 500,000 times larger.

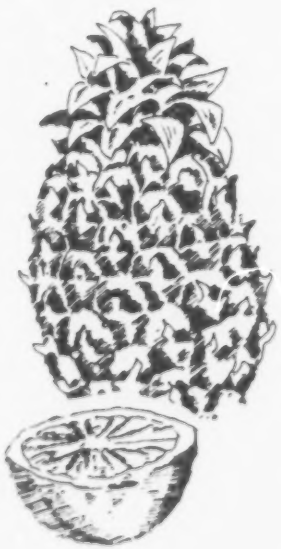
Scientists are racing to learn as much as possible about tropical rain forests. Have your class research and examine the problems that face rain forest environments. Role play solutions to these problems. Write to organizations for information, or adopt an acre of rain forest to help support research and preservation. There is a list of organizations provided at the end of this section. This issue's activities touch on major characteristics of rain forests and their inhabitants. Build a classroom rain forest, use rain forest calendars to fill

the classroom with pictures of the great diversity, research interesting plants and animals such as flying mice and river dolphins, write plays or adapt literature. The possibilities for rain forest study are endless. Teachers may want to construct an inventory for the class to find out how many rain forest products they use at home. After completing the inventory, graph the results and determine the origin of the products. Here is a beginning list:

Woods
- balsa
- mahogany
- rosewood
- sandlewood
- teak

Fruits and Vegetables
- avacado
- banana
- grapefruit
- guava
- heart of palm
- lemon
- lime
- orange
- papaya
- passion fruit
- pepper
- pineapple
- plantain
- potato
- sweet potato
- tangerine
- tomato
- yam

Canes and Fibers
- bamboo (cane furniture, crafts)
- jute (rope, twine, burlap)
- kapok (insulation, stuffing)
- ramie (knit materials)
- rattan (furniture, wicker cane chair seats)



Other Food Products
- Brazil nuts
- cashew nuts
- coconut
- coffee
- corn
- macadamia nuts
- peanuts
- rice
- sesame seeds
- sugar
- tapioca
- tea

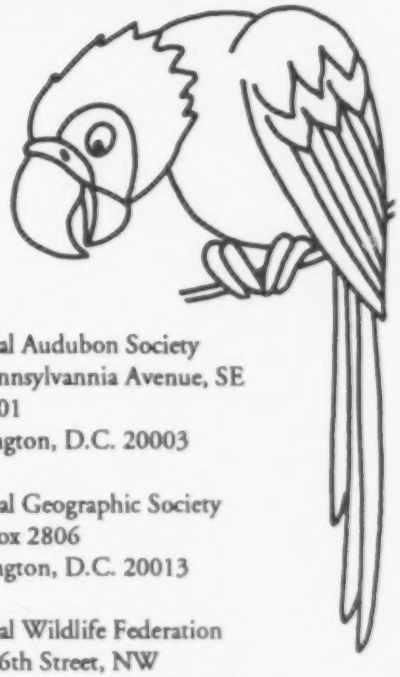
House Plants
- African violet
- aluminum plant
- *Aphelandra* (zebra plant)
- *Begonia*
- bird's nest fern
- bromeliads
- Christmas cactus
- *Croton*
- *Dieffenbachia* (dumb cane)
- *Dracaena*
- fiddle leaf fig
- kentia palm
- orchid
- *Philodendron*
- prayer plant
- rubber plant
- *Sansevieria* (snake plant)
- spathe lily
- swiss cheese plant
- *Schefflera* (umbrella tree)

Oils
- bay (bay rum lotion)
- camphor (insect repellant, medicine)
- coconut (snack food, baked goods, lotion, soap)
- lime (food flavoring, candles, soaps, bath oil)
- palm (snack foods, baked goods)
- patchouli (perfume, soap)
- rosewood (perfume)
- sandalwood (soap, candles, perfume)

Gums and Resins
- chicle (chewing gum)
- copal (varnish, printing ink)
- dammar (varnish, lacquer)
- rubber (balloons, erasers, foam, balls, elastics, glue, gloves, hoses, shoes, tires)

Spices and Flavorings
- allspice
- black pepper
- cardamon
- cayenne (red pepper)
- chili pepper
- chocolate or cocoa
- cinnamon
- cloves
- ginger
- mace
- nutmeg
- paprika
- tumeric
- vanilla

Organizations that provide rain forest educational materials:



- Manomet Bird Observatory
  Education Department
  P.O. Box 1770
  Manomet, MA 02345

- World Wildlife Fund/The Conservation Foundation
  1250 24th Street, NW
  Washington, D.C. 20037

- American Forestry Association
  P.O. Box 2000
  Washington, D.C. 20013

- Bat Conservation International
  P.O. Box 162603
  Austin, Texas 78716

- Center for Environmental Education
  1725 DeSales Street, NW
  Washington, D.C. 20036

- Earthscan
  1717 Massachusetts Avenue, NW
  Suite #302
  Washington, D.C. 20036

- Global Tomorrow Coalition
  25422 Trabuco Road
  El Torro, CA 92630-2792

- International Society of Tropical Foresters, Inc.
  5400 Grosvenor Lane
  Bethesda, Maryland 20814

- Missouri Botanical Garden
  Office of Education
  P.O. Box 299
  St. Louis, Missouri 63166

- National Audubon Society
  801 Pennsylvannia Avenue, SE
  Suite 301
  Washington, D.C. 20003

- National Geographic Society
  P.O. Box 2806
  Washington, D.C. 20013

- National Wildlife Federation
  1400 16th Street, NW
  Washington, D.C. 20036-2266

- Rainforest Action Network
  466 Green Street
  Suite 300
  San Francisco, California 94133

- Sierra Club
  Information Services
  730 Polk Street
  San Francisco, California 94009

- Smithsonian Institution Traveling Exhibition Service
  Office of Education
  Room 3146
  100 Jefferson Drive, SW
  Washington, D.C. 20560

- World Resources Institute
  1735 New York Avenue, NW
  Washington, D.C. 20036

Location of Tropical Rain Forests

There are 1.9 acres (770 million hectares) of tropical rain forests worldwide, according to 1987-1988 data. Approximately 40-50 million acres are lost yearly.

Ecosystems is a software program that allows students to examine food chains, populations, and food cycles. Questions cover the types of biomes that can be found in the United States and the changes that take place in these biomes. Apple II's. Grades 4 and up.

Rain Forest is a video that lets students journey to the dense rain forest of Costa Rica, where they can watch a basilisk lizard walk on water, howler monkeys bask in the sun, and leaf-cutting ants carry sections of leaves many times their weight to underground fungus gardens. Grades 2-8.
The above two items are available from:
Queue, Inc.
338 Commerce Drive
Fairfield, Ct 06430.
(800) 232-2224

A Field Trip to the Rainforest allows students to trek through a lush green rainforest with binoculars in hand by using the Macintosh as an exploratory learning tool. Includes a food chain simulation and a field guide that students can access to identify species. Available for the color Macintosh and Apple II's. Grades 2-8. The package includes a teacher's guide and a copy of the *Tropical Rainforests Nature Book.*

You Can't Grow Home Again is a video that takes students on a tour of Costa Rica's rain forest to view the habitat, species, and problems first-hand. VHS for grades 3 and up. Includes a teacher's guide with activity ideas.
The above two items are available from:
WINGS for Learning/Sunburst
1600 Green Hills Road
PO Box 660002
Scotts Valley, CA 95067-0002
(800) 321-7511

Rain Forest Rap is a video that is part of a comprehensive curriculum on rain forests. It includes Vanishing Rainforests book and teacher's guide, a full-color poster, and a black and white poster depicting the forest layers. This is an excellent, affordable package.

Roots of Life is a video that explores the contributions of plants to the quality of life. Considers the repercussions of total plant destruction.

Unknown Forests explores the reservoir of plant and animal species found in rain forests. Depicts unique interactions among all types of rain forest species.
The above items are available from:
World Wildlife Fund
1250 24th Street
Washington, DC 20037

Amazonia: A Celebration of Life is a video featuring rain forest species of Peru.
Joanna Viola
Dept. of Anatomical Sciences
Health Sciences Center
State University of New York
Stony Brook, NY 11797

The Rain Forest Imperative is a video and curriclum package geared for grades 6-12. It integrates many curriculum areas while highlighting Brazil's rain forests.
Macdonald's Education Resource Center
PO Box 8002
St. Charles, IL 60174-8002
(800) 627-7646

Human Population Growth and Tropical Forests is a slide program with narrative script that links poverty and industrial resource needs as causes of deforestation. A three-day loan costs $5.

What's the Limit? is a video that explores the relationship among population growth, human needs, environmental degradation, and family planning.
The above two items are available from:
National Audubon Society
Education Division
950 Third Avenue
New York, NY 10022

Our Threatened Heritage is a video that presents the wonders of tropical forests. Offers ideas and possible solutions.
National Wildlife Federation
1412 16th Street, NW
Washington, DC 20036

Tropical Rainforests: Diverse, Delicate, and Disappearing is a combination slide show and videotape package presenting forest diversity and splendor.
International Conservation Committee
Sierra Club
730 Polk Street
San Francisco, CA 94109

Get a free teacher's guide for **Earth's Birhtday Project/Adopt an Acre in the Children's Rain Forest** program.
Clifford Ross, Director
Earth's Birthday Project
170 Joralem Street
Brooklyn, NY 11201

The **Vanishing Rain Forest Education Kit** for grades 2-6, includes a booklet introducing the rain forest and its ecology, an illustrated teachers' manual with background information and activity suggestions, a poster depicting both threatened species and a rain forest in Borneo, and a six-minute Rain Forest Rap video. Send $29.95 plus $5 S&H. The video is sold separately for $15 plus $2 S&H.
World Wildlife Fund
PO Box 4866
Hampden Post Office
Baltimore, MD 21211

Trees of Life and **Saving Tropical Forests and Their Biological Wealth** are guides to the environment discussing dangers of over developing in rain forest areas.
(800) 822-0504

The Rain Forest Imperative is a 6-12 study unit and video on issues surrounding the rain forest crisis. Video highlights Brazil's Amazon rain forest. The cost is $9.95.
McDonald's Education Resource Center
PO Box 8002
St. Charles IL 60174-8002
(800) 627-7646

The **American Forestry Association** offers *Tropical Forests*, a color poster.
American Forestry Association
P.O. Box 2000
Washington, DC 20013

Bat Conservation offers *The Importance of Bats*, an article describing the ecological and economical importance of bats. They also have a catalogue of items including bat houses and curriculum materials.
Bat Conservation International
PO Box 162603
Austin, TX 78716

EARTHWATCH offers a *Tropical Forest Curriculum* based on teacher/volunteer expeditions to rain forests around the world.
EARTHWATCH
Box 403
680 Mt. Auburn Street
Watertown, MA 02272

General Learning Corporation offers *Exploring the Tropical Rain Forest*, an activity poster with plenty of ideas.
General Learning Corporation
3500 Western Avenue
Highland Park, IL 60035

The **Missouri Botanical Garden** offers tropical forest *materials* and a curriculum.
Stephanie Finke
Education Division
Missouri Botanical Garden
PO Box 299
St. Louis, MS 63166

The **National Audubon Society** offers *Tropical Forests: A Global Treasure in Peril*, an activity guide and poster; and fact sheets on *You Can Save the Tropical Forests, Tropical Forest Reading List, Tropical Forests: A Call to Action*, and *Tropical Forests and Biodiversity Bills.*
National Audubon Society
801 Pennsylvania Avenue, SE
Washington, DC 20003

The **National Wildlife Federation's** NATURESCOPE series offers *Tropical Treasures*, the January 1989 issue on rain forests. It contains activities, student sheets and resource lists.
National Wildlife Federation
1412 16th Street, NW
Washington, DC 20026

The **World Resources Institute** offers materials with ideas and facts. *Keep Tropical Forests Alive, Tropical Forestry in Action*, and *Tropical Forests: A Call to Action* are all available.
World Resources Institute Publications
1735 New York Avenue
Washington, DC 20006

Celestial Arts offers a *glow-in-the-dark rain forest poster* set. The poster also comes geared for pre-primary students.
Celestial Arts
PO Box 7327
Berkely, CA 94707

Save the Rainforest offers a *Teacher's Guide to Environmental Action.*
Save the Rainforest
604 Jamie Street
Dodgeville, WI 53533

Ecol-o-kids offers a *poster* of rain forest species with an identification chart.
Ecol-o-kids
3146 Shadow Lane
Topeka, KS 66604
(800) 423-7202

The **World Forestry Center** offers a *Tropical Forest Kit* containing resources for developing curriculum. The kit rents for $25 for two weeks.
World Forestry Center
Education Department
4033 SW Canyon Road
Portland, OR 97221

Earnest Endeavors offers *Color Me Saved No. 1: The Rain Forest*, a coloring poster depicting the forest and its inhabitants. It is available for $8.
Earnest Endeavors
1807 N. 79th Street
Elmwood Park, IL 60635

Request a **Resource Package** encouraging K-12 students to become involved in community service activities. Package includes a classroom guide providing a step-by-step plan for teachers to use with students.
StarServe
701 S. Monica Blvd.
Santa Monica, CA 90401
(800) 888-8232

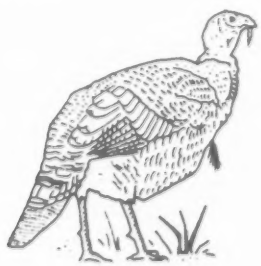
Request **classroom materials and activities** to acquaint teachers and students with the problems and solutions of world hunger. Please specify grade levels.
Patricia Young
National Committee for World Food Day
101 22nd Street, NW
Washington, DC 20437

Citizen's Guide to Ground-Water Protection is a booklet listing sources, movements, storage, and use of groundwater, laws protecting groundwater, contamination, and how citizens can protect groundwater. Single copy free.
US. Environment Protection Agency
Office of Groundwater Protection
(202) 382-7077

Cafeteria Composing Guidelines is a how-to booklet on classroom composing.
Division of Solid Waste Management
Agency of Natural Resources
103 St. Main St.
Laundry Building
Waterbury, VT 05676

Magellan: Venus Explorer's Guide contains resource materials on the Venus mission such as technical background, photos, and diagrams.
Magellan Project Office
Jet Propulsion Lab
4800 Oak Grove Drive
Pasadena, CA 91109

Friends of the Earth is a newsletter featuring technical and legal issues simply explained. Each article contains a "what you can do" section. Subscriptions $25.00.
Friends of the Earth
218 D Street, SE
Washington, DC 20003



Math Power in School provides teachers with hands-on classroom activities to improve student performance in math classes. Includes problem-solving, estimation, and conceptual understanding. **Math Power at Home** and **Math Power in the Community** provide supporting activities for outside the classroom. Topics include patterns and symbols, rational numbers, geometric and spatial reasoning, probability, and statistics. The cost is $9.95 each or $19.95 for the set of three books. Include $4.00 for postage and handling.
AAAS Books
PO Box 753
Waldorf, MD 20604

Coastal Connection is a newsletter on beach cleanup activities, and **Popeye** is a poster of Popeye reminding boaters not to throw trash overboard.
Center for Marine Conservation
1725 DeSales Street, NW
Washington, DC 20036

Catalogs of more than **1,000 videos, slides, toys, models,** and other items on astronomy and space are available.
Black Forest Observatory
12815 Porcupine Lane
Colorado Springs, CO 80908

Free single copy of **Helping Your Children Learn Science,** a booklet of science activities.
Consumer Information Center
Pueblo, CO 81009

A flyer from **The Herbarium** offers rubber stamps and accessories, environmental education materials, teacher resource books, and science games and kits. Cost is $2.00 for catalog (refundable with order). Enclose a SASE.
The Herbarium
PO Box 246836
Sacramento, CA 95824

WonderScience Magazine is an annual hands-on, activity-based, physical science magazine for grades 4-6. Cost is $5 plus $2.50 postage and handling for four issues.
Jim Kessler
American Chemical Society
1155 16th Street, NW
Washington, DC 20036

The **Shaping of Things to Come** is a kit on plastics. Write on school letterhead.
The Naidus Group
PO Box 12057
Hauppauge, NY 11788

Conserving Marine Resources-A Primer of Key Considerations is a booklet containing suggestions on getting involved in protecting ocean life and building active community support.
National Audubon Society
550 S. Bay Avenue
Islip, NY 11751

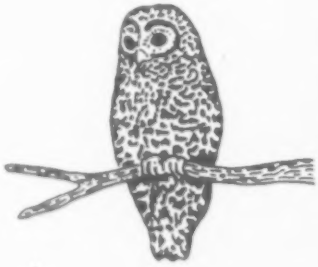
Focus on Science Education is a quarterly newsletter highlighting science education, news, teaching tips, short activities, and resources. Annual subscription cost is $5.00.
(415)-750-7115

From Mountains to Metals is a poster on rocks, minerals and the mining industry.
The reverse side contains information about common rock types, their formation, minerals, elements and groups, and crystal systems. Cost is $3.00.
Mineral Information Institute
1125 17th Street, Suite 1800
Denver, CO 80202

Teaching our Teachers is *Education Week's* special report on education, colleges, the special challenges of preparing elementary school teachers, and the need to revamp clinical teacher education training. Cost is $4.00.
Education Week Special Report
4301 Connecticut Avenue, NW
Suite 250
Washington, DC 20008

Global Warming Activities are available in two booklets, one for *science classes* and one for *social studies classes*. Cost is $9.85 each; $18.00 for both.
Climate Protection Institute
5833 Balmoral Dr.
Oakland, CA 94619

The **Newspaper as an Effective Teaching Tool** is a guide to using newspapers in the school curriculum for grades 4-8. Cost is $5.00.
American Newspaper Publishers Foundation
Box 17407
Dulles Airport
Washington, DC 20041



Twenty **science booklets** for grades K-1 include lessons, experiments, reproducibles, and a list of stories. Includes genetics, ecosystems, geology, astronomy, evolution, and energy. Cost is $5.00 each booklet. Send a SASE for a complete listing.
Cynthia Hinojosa
7272 Elk Circle #1
Huntington Beach, CA 92647

Mending the Earth: a World for our Grandchildren is a book of articles by leading conservationists on grassroots political action, energy efficiency, population growth and other topics. Cost is $9.95.
North Atlantic Books
2800 Woolsey St.
Berkeley, CA 94109

Population Images is a set of computer graphics on world population growth for classroom use. World trends and patterns in time frames from 1925 to 2025 are covered. Cost is $7.50 plus $1.50 postage and handling.
Population Images
PO Box 7239
Washington, DC 20044

Dynamic Planet, a five foot wide world map shows locations of 1,450 volcanoes active during the past 10,000 years and more than 140,000 earthquakes. The map shows locations/movements of tectonic plates making up the earth's crust. Cost is $4.00 plus $1.00 postage and handling.
Map Distribution Center
US Geological Survey
Federal Center
Box 25286
Denver, CO 80225

Guidelines for Developing Oral Communication Curricula in Kindergarten through Grade Twelve is a booklet to help instructors teach students appropriate oral communication skills. Cost is $6.00 plus $1.50 S&H.
Speech Communication Association
5105 Backlick Road, #F
Annandale, VA 22003

Request a copy of **Everybody's Guide to Water Terms**, #21403 for 50 cents.
ANR Publications
64701 San Pablo Avenue
Oakland, CA 94608-1237

Ground Water Education in America's Schools is a catalog describing 42 resource packages for classroom instruction. Schools may obtain a *free single copy* for the cost of $2.00 for postage and a 9-by-12-inch SASE.
American Ground Water Trust
6375 Riverside Drive
Dublin, OH 43017

Request a sample issue of the **Education Writer's Newsletter** a publication for teacher-writers. Cost is $5.00.
Share your Excellence Enterprises
Box 2152
Amherst, MA 01004-2152

The **Fish Boom Bah** kit allows students to learn about fish firsthand. Return an enclosed coupon to receive suspended killifish eggs, and water to activate the embryonic process. The fish appear in 30 minutes. Also available is **Can-O-Fish**, containing killifish eggs, tank, and food. Both are appropriate for K-12. Cost is $14.95 plus $3.00 for S&H for Fish Boom Bah or $12.95 plus $3.00 for Can-O-Fish.
Orbis Scientific
PO Box 3890
Milton, FL 32572

Planting Seeds: Growing Minds is a curriculum for K-6 which teaches about seeds, plants, flowers, and trees. Curriculum features 11 lesson plans with summary, background, preparation, procedure, and extension ideas. 1-5 units cost $5.00 each, 6-20 cost $4.00 each. Discount on bulk quantities is available.
California Association of Nurserymen
4620 Northgate Blvd.
Suite 155
Sacramento, CA 94834.

The **1991-1992 Educators Guide to Free Science Materials** describes books, films, filmstrips, and videos. Revised annually. Free 15 day examination. Cost is $26.25.
Educators Progress Service
214 Center Street
Randolph, WI 53956

Planet Patrol: An Environmental Unit on Solid Waste Solutions for grades 4-6 comes with teacher's guide, student activities, and poster. Cost is $1.75.
Proctor and Gamble Educational Services
PO Box 599
Cincinnati, OH 45201-0599

The **Museum of Science, Boston** has developed 15 interdisciplinary/*science* curriculum kits filled with activities, materials, instructions and resource lists for elementary classrooms. Topics include life science, physical science and earth science. Kits can be rented for five weeks for $98. They can be picked up at the museum or shipped anywhere for an additional charge. Call for a current topic list.
Museum of Science, Boston
Science Park
Boston, MA
(800) 722-5487

CHAMELEON CAPERS

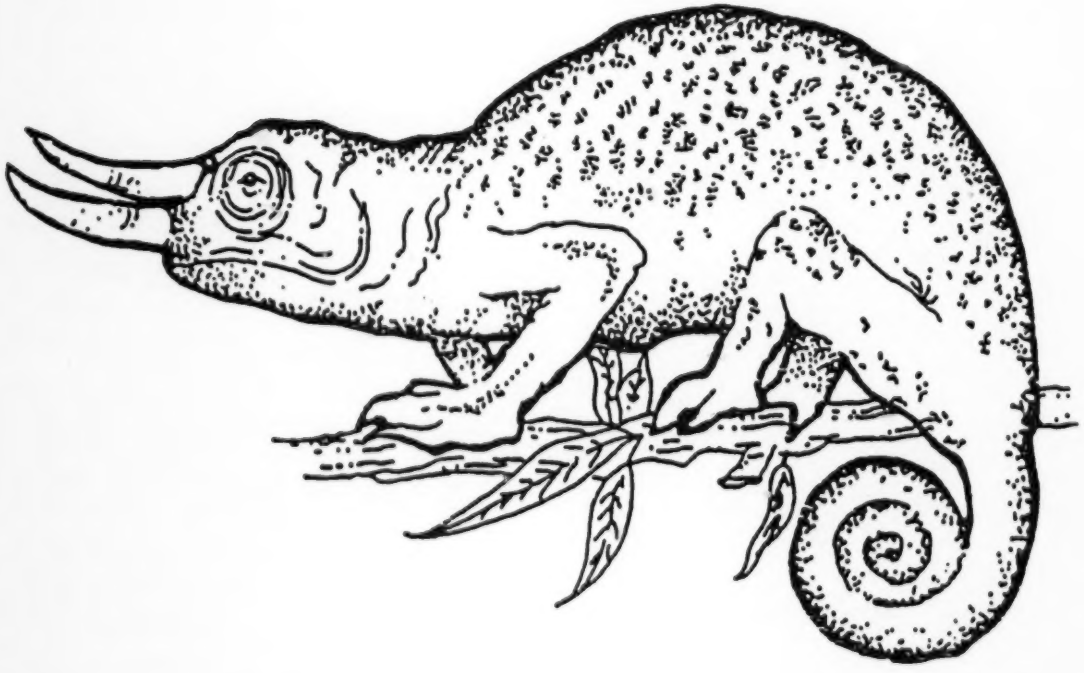
Objective: Students will observe their classroom environments, and then choose an area in which to camouflage a rain forest chameleon. They will have first-hand experience with the concept of protective coloration.

Materials:
- chameleon pattern, one per student
- crayons
- scissors

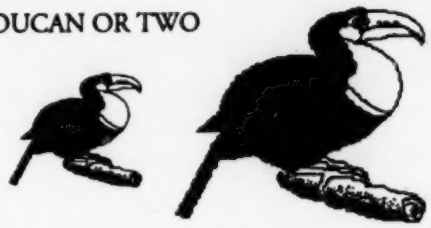
Procedure:
1. Students should each choose an area of the classroom to become a "mini-habitat". They must color their chameleon pattern so that it will blend in with the chosen habitat.

2. Once chameleons are colored, they should be mounted in the habitat area. Remember not to place patterns under anything. The coloration should be enough to conceal the chameleons. Then invite another class in to find the "hidden lizards". Students whose chameleons are found right away often wish to try again. The second time their camouflage usually works.

Adapted from the Museum of Science, Boston. Origin of workshop unknown.

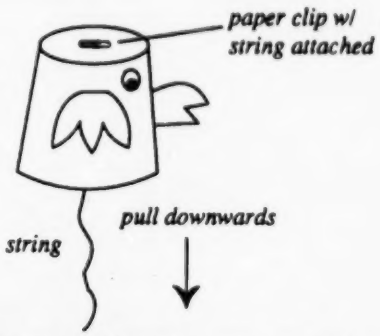


A TOUCAN OR TWO



Objective: Students will explore the concept of sound resonance using tropical toucans as a model. They can vary the sound by changing the size of the toucan model. The bigger the sound chamber the lower the noise. The lower the noise, the less sound carries. Birds that are hidden in the thick canopy have to find each other or mark their territory by making as big a sound as possible.

(A)
Toucan
model:



Materials:

- plastic Dixie-type drinking cups, various colors and sizes (4 oz., 6 oz., 8 oz.)
- 10" piece of string per student
- scissors
- paper clips, one per toucan
- toucan bill pattern (B), cut from colored oaktag
- small amount of water
- construction paper
- glue or sticky tape
- large oaktag graph prepared on wall (C)
- yardsticks or tape measures
- chalk
- pencils; oaktag strips (D)

Procedure:

1. Each student should choose a cup size and color. Using the bill pattern (B) and construction paper for eyes, wings, and tail, students should design their own birds by transforming the cup into a toucan (A).

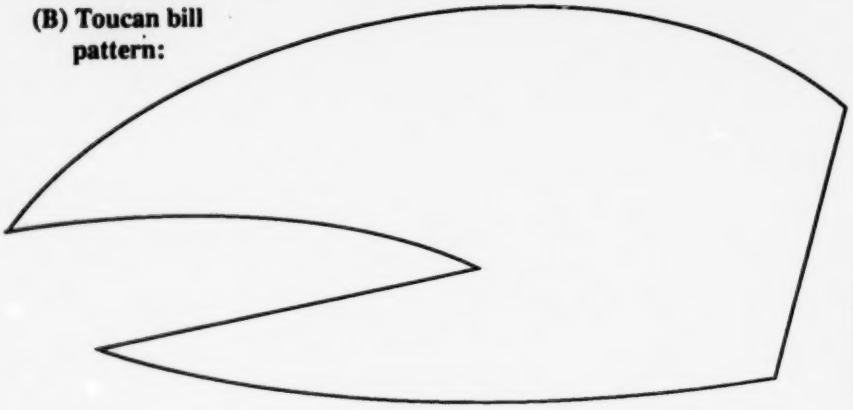
2. Each student should poke a small hole in the bottom of the cup (which is the top of the toucan's head when the model is finished). Teachers should do this for younger students. Tie the piece of string to the paper clip. Place the string through the hole in the cup so that the paper clip acts as an anchor on the cup bottom, and the string hangs through the cup and below the the model (A).

3. Students should try holding the toucan firmly with one hand and pulling the other hand down the string. What happens? Now try wetting the string before pulling. What happens? The wetness decreases the friction while pulling, increasing the vibrations. These vibrations resonate inside the cup producing a higher sound. What differences in sound are observed when using smaller or larger cups? Why do you think this happens? Which sound would be more useful in the rain forest canopy?

4. What might happen if students made another model using a material other than string inside the cup? Students might also create other rain forest birds using the basic model and adding other bills, wings, and details.

5. Prepare a large graph on oaktag (B) on the wall before starting this part of the activity. Students will then graph their toucans' sounds working in teams of two in the hall or preferably on the playground. To insure accuracy, measure each distance twice and take an average. Each student should use an oaktag strip with their name, size of "toucan" used (4 oz. cup, 6 oz. cup...), and distance of test (D).

(B) Toucan bill pattern:

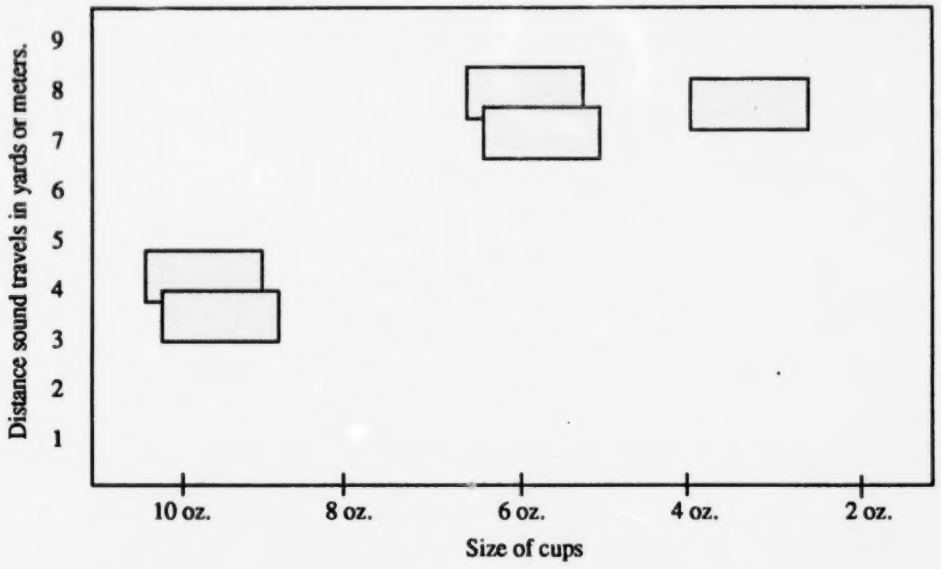


(D) Oaktag Strip:

Name: _____ Distance:_____

Cup size: _____ Trial #:_____

(C) Graph:



6. One member of each team makes their toucan vibrate and produce sound while the other teammate walks away with their back toward the sound maker until they can just not hear the sound anymore. Mark the distance with a stick outside or chalk inside. Measure that distance and record the answer on an oaktag strip. Reverse roles, repeat the activity, measure, and record the distance sound travelled for the second "toucan" on a second oaktag strip.

7. Stick each measurement strip onto the large wall graph. Consider what conclusions can be drawn from the data collected. How could the data be made more reliable? (Repeat the sound and distance tests more times.)

Beverly Maffei and Arlene Nichols. MITS, Inc., 1993.

WHAT'S IN A WORD?

Objective: Students will better understand the meaning of the words safe, threatened, endangered and extinct, through a simulation game with rain forest bats and graphing game results.

Background: Bats have long instilled fear in humans. There are many stories surrounding these night mammals, but few people have the facts. Bats are the only flying vertebrates besides birds. They comprise almost a quarter of ALL mammal species. Hundreds of bat species are found in rain forests. Fifty-thousand bats can consume up to 13 tons of insects annually. Bats eat fruit pollen, nectar, and other plant material, and function as important agents of pollination and seed dispersal. in rain forests. A decline in bats effects plant populations.The bat pattern is a flying fox, the largest bat and a rain forest inhabitant.

Materials:

- chart paper and markers or chalkboard

For groups of three students:

- bat pattern copied in four colors and cut into individual bats
- paper plate
- large poster board
- markers/glue

Procedure:

1. Each group of students will represent a rain forest country. Mix up the colored bats and distribute them among the "countries" (on the paper plates), being sure that each group has some of each color. The colors represent species of bats. Each country begins with a healthy, diverse population of bats.

2. As a class, brainstorm changes in habitat that might affect bat populations such as disease, habitat loss, pollution, killing, etc. Are these specific to rain forests or are some of these factors affecting local populations as well? Post the list on the board or chart paper. Begin the game by calling out a change and a number of bats it affects. At each call, students remove that many bats of any color from their plate. After five calls, the game ends.

- 3 bats die from disease
- 2 bats die because they ate insects sprayed with pesticides
- 3 bats die because their caves were disturbed
- 2 bats are killed by humans
- 3 bats die after an intense storm

3. Students now count and graph their bat populations according to the end results of the game. On the poster board, each group of students should make four columns labeled Safe, Threatened, Endangered, and Extinct. If there are no bats left of a certain color, that species is obviously extinct in that country. Students must then discuss their numbers and place the bat patterns on the graph to match the category in which they feel each species belongs. A large number of a color would be a healthy of "safe" population. The fewest number of a color would be "endangered". What about "threatened"? How will students decide? Students should be prepared to discuss their choices.

Safe	Threatened	Endangered	Extinct

4. Bring all groups together and discuss results. Each group should present and defend their graph. Then, as a class, discuss how scientists count and categorize plants and animals, and any steps that could might be taken to try to prevent any extinctions or increase endangered populations.

5. Each student group should choose a rain forest bat species to research. Based on the research information, groups should then develop a public awareness campaign featuring a button, poster, or slogan. The campaign should list the facts, identify problems the particular bats face and suggest solutions. The groups should choose an audience for the campaign and a method of presenting what they have accomplished.

Adapted from Vanishing Rainforests Teachers' Guide, Copyright World Wildlife Fund, 1988.

SHRINKING HABITAT GAME

Objective: Students will better understand the dangers of shrinking habitat to the species that depend upon it. through a simplified simulation game. This activity should be saved for after some research on rain forest habitats and habitat loss has been done.

Materials:

- chart paper and markers or chalkboard
- books on rain forest plants and animals
- pencils
- safety pins
- long rope
- 6" x 6" cards, 1 per student for rainforest speciespictures and information

Poison Arrow Frog

The poison arrow frog has a brightly colored body. The bright colors warn other animals that it is poison. The frog makes its home in trees or on the floor of the rainforest. It eats insects.

Procedure:

1. Students will take part in a simulation that demonstrates results of habitat loss. Begin by having students choose a specific rain forest animal or plant to research. Students should illustrate their plant or animal on one side of a 6'" x 6" card, and write five facts about it on the other side. Shuffle and distribute cards so that each student pins a new card to his or her shirt when the game starts. If you want to save time, use the cards provided. Enlarge the cards for game.

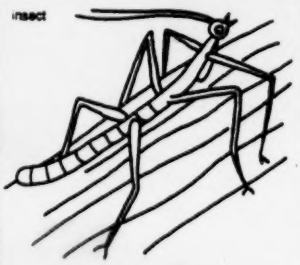
2. To begin playing, brainstorm possible reasons for habitat loss and record these on the chart paper or chalkboard. Some examples of habitat loss include: a dam was built and flooding occurred; lightning started a fire which destroyed habitat; farm animals were allowed to over-graze, reducing food supply; erosion was caused by severe flooding; unrestricted over-development fragmented the habitat; massive, unrestricted slash and burn agriculture took place.

3. Then clear the floor and lay the rope in a circle to represent a rain forest. Each student should pin on a new picture of an animal or plant, and step into the "rope forest". Have three students stand around the outside of the circle to control the rope. The teacher should begin calling out the discussed causes of habitat loss, one at a time. Each time a cause is called out, the outer students tighten the rope, "shrinking" the rainforest area. When the rope touches a student, he or she must step out. Students will begin to compete for space, but no pushing is allowed. They must stay inside the rope to survive, but as the area becomes smaller, students will begin to fall out.

4. End the game after the list has been called. What happened as more causes were introduced? How did students feel as the habitat became more crowded? Which cause do students feel have the most effect on habitat loss? Can this be determined at all? What is the difference in effects of natural or human-made causes?

Adapted from *Rainforests Teacher's Guide*, Kids for Conservation. Copyright Marine World Africa USA. and *Exploring the Rainforst*, copyright CopyCat Press, 1991.

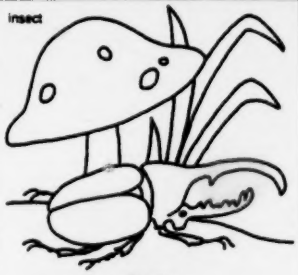
insect



Walking Stick

The walking stick is an insect with a long body, six legs that are all the same size, and no wings. It is brown and looks like a stick. This protects it from enemies. The walking stick eats leaves and as it grows, it sheds its skin.

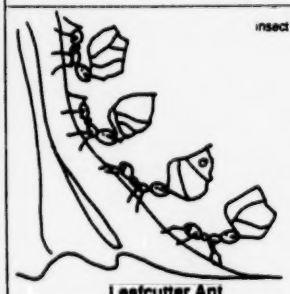
insect



Beetle

Beetles are one of the largest groups of insects that live in the rainforest. Tough, brightly colored front wings protect the underwings that are used for flying. Beetles have strong jaws for chewing leaves and fruit. Some beetles grow to be giant-sized.

insect



Leafcutter Ant

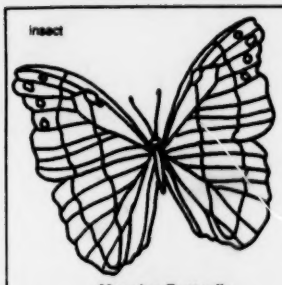
Leafcutter ants are the farmers of the rainforest. These red ants cut pieces of leaves and carry them like umbrellas over their heads. They walk in a long line to their underground nest. In the nest, they chew up the leaves and grow fungus to eat.

insect

Army Ant

Army ants move in long columns around the floor of the rainforest. Slow moving insects or animals hurry to get out of the way because they may be eaten by the fast moving ants. Army ants make a nest by clinging together in a large ball.

insect



Morpho Butterfly

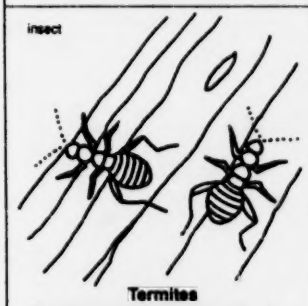
Morpho butterflies are large, beautiful butterflies. Their sparkling blue wings flash in the sunlight as they fly through the clearings in the canopy of the rainforest. Morphos flutter from flower to flower drinking nectar.

insect

Moth

Many kinds of moths fly at night in the rainforest. The body of the moth is short, furry, and plump. Its antennae are often feathery. Some moths have colorful wings. They use their sense of smell to find flowers and then drink the nectar.

insect



Termites

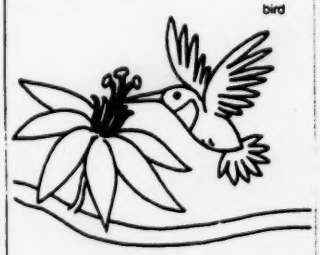
Termites are small insects that are found everywhere in the rainforest. They live together in colonies and eat wood. Termites build large nests in trees or huge mounds on the ground. These mounds are often taller than a man.

reptile

Anaconda

An anaconda is a very large olive green colored snake. It has two black stripes on its head and black spots along its back. This slow moving anaka lives near the water and catches birds and small animals that come to drink.

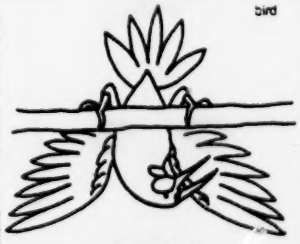
bird



Hummingbird

A hummingbird is one of the smallest and most colorful birds. Its wings make a humming sound as it darts quickly forward, backward, and sideways in the rainforest. The hummingbird's long slender bill sucks nectar from flowers.

bird



Oropendola

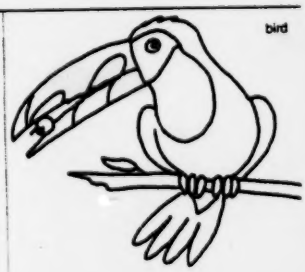
Oropendolas are birds that like to hang upside down. They live in large flocks and build long hanging nests in the trees. Oropendolas eat soft fruit and drink nectar. Sometimes a cowbird puts its eggs in the oropendola's nest and the oropendola becomes a baby-sitter.

bird

Paradise Tanager

A paradise tanager is a small bird with black, red, purple, and green feathers. It builds a cup-shaped nest and likes to eat insects, fruit, and flowers. The paradise tanager has colorful relatives also living in the treetops of the rainforest.

bird



Keel-billed Toucan

A keel-billed toucan is a strange-looking bird with a huge bill of many colors. The bill looks heavy but air pockets make it light. The saw-like edges of the bill slice fruit to eat. The toucan lives in a flock and sleeps with its big bill resting on its back.

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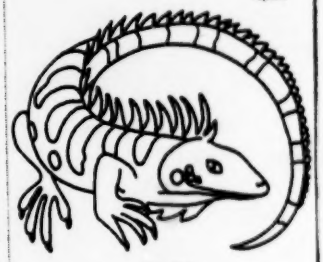
reptile

Tree Boa

A tree boa is an orange snake. It spends its days coiled and sleeping in a tree. At night this slow-moving snake hunts and eats lizards, birds, and small mammals.

reptile



Iguana

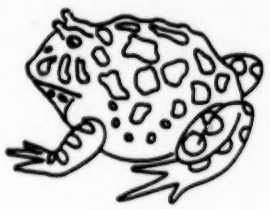
The iguana is a large green lizard that lives in the trees of the rainforest. It eats insects and can grow as long as six and one-half feet, including its long banded tail. A large flap of skin hangs from the iguana's throat.

amphibian

Red-eyed Tree Frog

The small red-eyed tree frog lives in the trees and shrubs of the rainforest. It leaps from tree to tree looking for insects to eat. Sticky pads on its long toes make the tree frog a good climber.

amphibian



Horned Frog

The horned frog is large with a big head and a wide mouth. Its body is covered with colorful patterns and flaps of skin that look like horns. Hiding in the soft ground, the horned frog leaps out to eat insects, frogs, lizards, and snakes.

reptile

Caimen

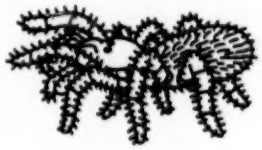
The caimen is a reptile that looks like an alligator. It can be seen sunning itself along river banks or swimming in streams. The caimen moves very fast and has many sharp pointed teeth. It catches and eats water birds, mammals, amphibians, and other reptiles.

reptile

Fer-de-Lance

The fer-de-lance is a poisonous snake that lives mostly on the ground in the rainforest. It is a dark brown-grey color with a black-edged diamond pattern on its back. It has long sharp fangs and eats small animals, lizards, frogs, and rodents.

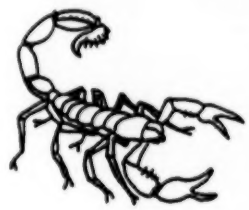
spider



Tarantula

A tarantula is a large hairy spider that lives in the trees of the rainforest. It hunts at night and eats insects. Sometimes it eats small birds. Tarantulas can live to be 20 years old. Their bite is not poisonous to people.

spider



Scorpion

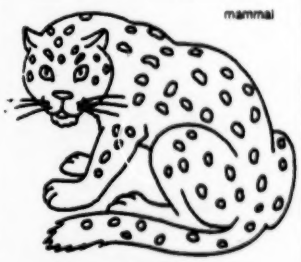
The scorpion is a member of the spider family. It has a long tail that gives a dangerous, poisonous sting. The scorpion lives in the trees of the rainforest and is most active at night. It eats large insects and other spiders.

mammal

Jamaican Bat

The Jamaican bat, a mammal that can fly, lives in the canopy of the rainforest. It has a furry body and wings covered by skin. The bat uses its sense of smell to find and eat fruit. It spreads the seeds from the fruit and helps pollinate flowers.

mammal



Jaguar

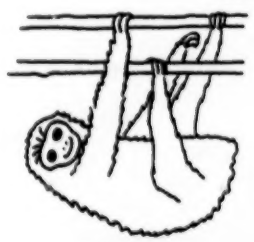
The jaguar is a large, wild cat that is very strong. Its golden fur has many black spots. The trees in the canopy of the rainforest and the forest floor are home for the jaguar. It is a night hunter and likes to eat rodents and other animals.

reptile

False Coral Snake

The false coral snake has a pattern of coral and dark green rings around its long, thin body. It lives in the trees of the rainforest and rests during the day. At night it hunts small lizards, other snakes, and insects.

mammal



Two-toed Sloth

A two-toed sloth moves very slowly. It hangs upside down in the canopy of the rainforest. The sloth eats leaves, fruit, and tender twigs. Green algae often grows on its light brown fur and many insects make a home in the algae.

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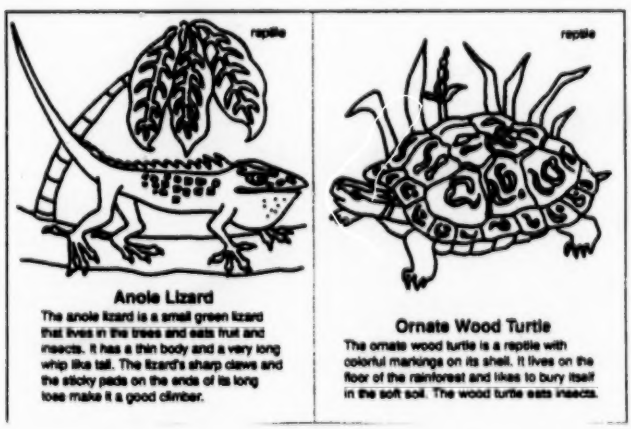
mammal
Spider Monkey
The spider monkey has black, brown or golden fur and a very special tail. The tail helps the monkey hang from trees and reach for fruit to eat. Spider monkeys live in the canopy of the rainforest but may be found high in the trees and also on the ground.
mammal
Tamandua Anteater
The tamandua anteater lives in the trees of the rainforest. Its long tail wraps around a branch to hold on. The tamandua has gray-brown fur and sharp claws. It opens the nests of termites and ants with its claws and eats the insects with a long tongue.
mammal
Armadillo
The armadillo's body is a shell made of bony plates. It lives in an underground den. An armadillo digs with its strong claws and finds ants, termites, spiders, snails, snakes, and roots. It licks up the insects with a worm-shaped tongue.
bird
Macaw
A macaw is a beautiful parrot with blue, red, yellow, or green feathers. It has an arched bill and a very long tail. The macaw lives with other macaws. It flies from tree to tree making loud screeching noises and eating nuts, seeds, and fruit.


reptile
Anole Lizard
The anole lizard is a small green lizard that lives in the trees and eats fruit and insects. It has a thin body and a very long whip like tail. The lizard's sharp claws and the sticky pads on the ends of its long toes make it a good climber.
reptile
Ornate Wood Turtle
The ornate wood turtle is a reptile with colorful markings on its shell. It lives on the floor of the rainforest and likes to bury itself in the soft soil. The wood turtle eats insects.

Copyright CopyCat Press, *Exploring the Rainforst*, 1991.

CAN'T SEE THE FOREST FOR WHAT TREES?

Objective: Students will explore the results of a renewable resource being used faster than it is replaced. In this simulation an area of rain forest can be located on a map and considered to be the area affected.

Materials:
- clock that indicates seconds
- 120 craft sticks
- coffee can
- 32 craft sticks wrapped with a rubber band

Procedure:

1. Each member of the group should take a part: lumberjack, forest, forest manager, and timer.

2. Give 120 craft sticks in a coffee can to the student playing the forest. These sticks represent the trees available to the lumberjack for cutting.

3. Give 32 craft sticks to the forest manager. These sticks represent trees growing during the game.

4. The student lumberjack keeps track and records the transfer of trees each minute on the diagram shown.

5. When the timer gives the signal, begin playing. After 15 seconds, the timer tells the forest manager to give the forest one tree. Every 15 seconds for the rest of the game, the forest manager adds another tree to the forest. The forest manager is simulating the average rate at which trees grow to maturity and become timber reserves in the real world.

6. Stop at the end of the first minute of the game and let the lumberjack remove one tree from the forest. The tree represents the amount of wood the world needs for heating, cooking, and buliding materials at its present population. Record the transfer of trees on the chart.

7. Continue playing. At the end of each succeeding minute, the world's demand for wood doubles as a result of the growth of the population. At the end of the second minute, the lumberjack cuts two trees from the forest; at the end of the third minute, the lumberjack cuts four trees from the forest; and so on.

8. End the game when the wood reserves in the forest can no longer meet the demands of the lumberjack. Analyze what happened. How many minutes did it take for the lumberjack to cut all the trees in the forest? Was the forest always shrinking? If the forest manager could develop a faster growing tree, one that grows at the rate of one tree per second, would tree growth keep up with timber demand? Why not? What couldbe done to prevent the demise of the forest?

Adapted from CONSERVATION, Volume 4 Number 2. MITS, Inc., 1992.

Minutes	Trees at beginning of min.	New trees	Trees cut	Trees at end of min.
1	120	+4	-1	123
2				
3				

ROOT CAUSES

Objective: Students will explore the unusual buttress and stilt root types of rainforest trees. These root types are also sometimes found in wetland habitats. Rainforest trees reach great heights, yet the soils in these areas may be so poor they only allow roots to penetrate to very shallow depths. Students will create root systems that can overcome this difficulty.

Materials:

- five 1/4" or 5/8 " diameter dowel rods
- 30 pipe cleaners
- 30 index cards
- tape and scissors
- soil or sand
- 5 shallow pans, approximately 1 foot square and 1" to 2" deep

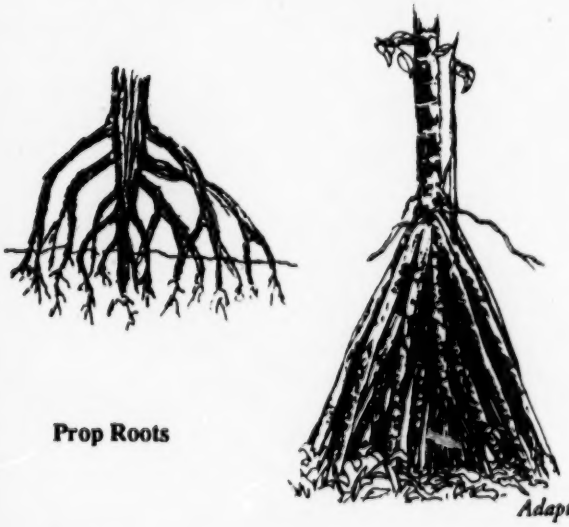
Procedure:

1. Prepare the activity ahead. Fill one pan with soil to a depth of 2 to 3 inches. Fill the other pans with a layer of soil only 1/2 inch deep. Saw or cut the dowels to a length of 18 inches. Tape the ends of 3 pipe cleaners to the end of one dowel.

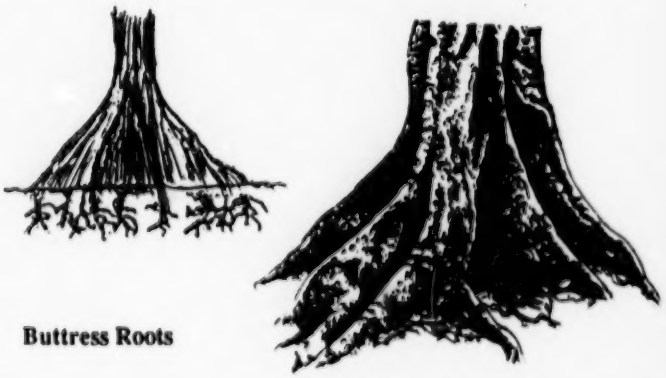
2. Ask students how a tree stays standing. Roots of temperate trees generally take advantage of the soil by burrowing deeply for support. Demonstrate this with the first dowel rod. The attached pipe cleaners represent roots. By burying them in the soil you can easily keep the dowel upright. Now pull up the tree and try putting it on the thin tropical soil. The roots have nothing to bury in and the tree falls over.

3. Divide students into small groups. Supply each with a dowel rod, 3 pipe cleaners, an index card, scissors and tape. The challenge is to invent a root system capable of supporting the dowel "tree" in the thin tropical soil.

4. After the groups have had time to experiment, pull together and share results. Discuss the various strategies students have developed. Two common strategies tropical trees have developed are prop roots and buttress roots. Prop roots begin above ground and provide support by radiating out from the trunk. These can be built using the pipe cleaners. Buttress roots look like the architectural buttress on some buildings, or like wings projecting out from the base of a tree. These can be modeled with the index cards.



Prop Roots



Buttress Roots

Adapted from New England Aquarium. Copyright 1990, Alexander Goldowsky.

BROMELIAD WORLDS

Objective: Students will create simplified models of bromeliads, a rain forest plant. Bromeliad (bro-MEAL-ee ad) plants grow abundantly on the trunks and branches of trees. Since the bromeliad cup retains water and the sheltering leaves provide protection, the plant makes a mini-habitat for frogs, snakes, insects and other animals. The illustration after the activity shows the inhabitants of this unique mini-habitat. Students may want to make more intricate bromeliad models as shown in the following diagram or research the various animals found in the illustration.

Materials:

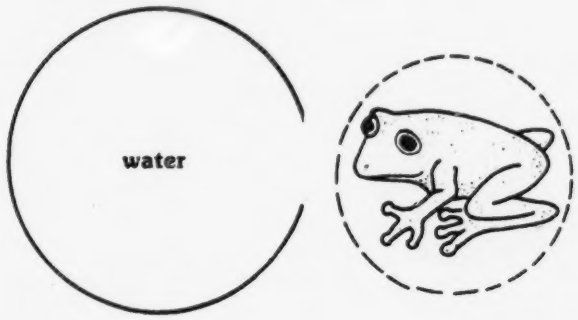
- pictures of bromeliads or borrow one from a florist
- copies of the pattern
- 1 toilet paper roll per bromeliad
- green and blueconstruction paper
- pencils
- scissors
- clear tape or glue
- crayons or markers

Procedure:

1. From green construction paper, cut out 4 leaf patterns per bromeliad. Wrap one of the leaves around the top of the toilet paper roll, so that most of the paper extends beyond the edge. Tape the two ends of the construction paper together, and then tape the construction paper to the roll. Curl each leaf by wrapping it around the fingers and holding it in place for a few seconds.

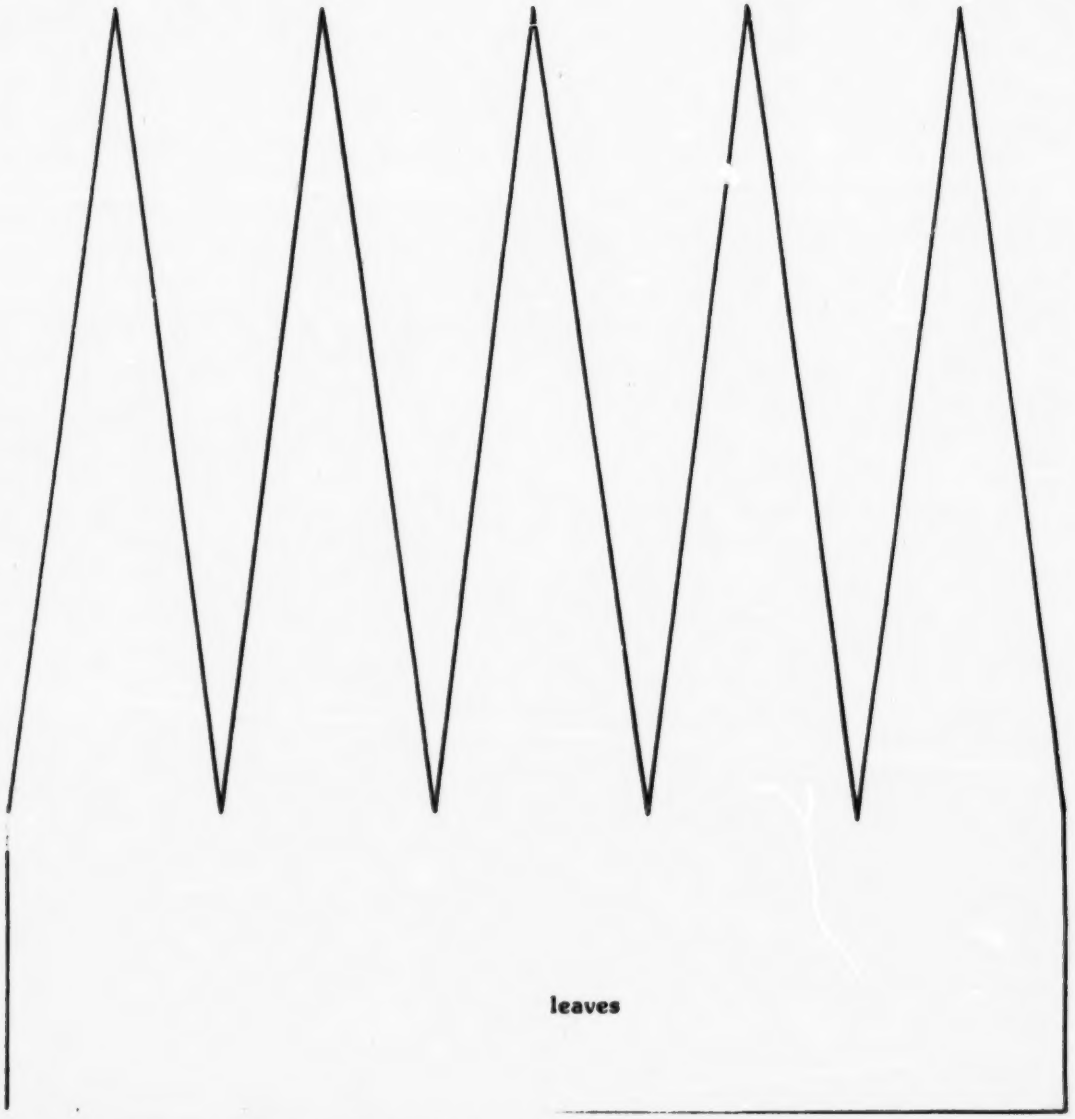
2. Wrap a second leaf pattern around the roll so that it overlaps the bottom of the top leaf. Shift it around so that each of its leaves falls between two of the leaves above it. Tape the leaf and then tape it to the roll. Curl these leaves as well.

3. Wrap the remaining two leaf patterns around the roll one at a time, making sure that each leaf falls between leaves already taped in place above it. Curl the leaves. The last leaf pattern should cover the rest of the toilet paper core. Trim any excess construction paper that's protruding from the bottom edge of the roll.



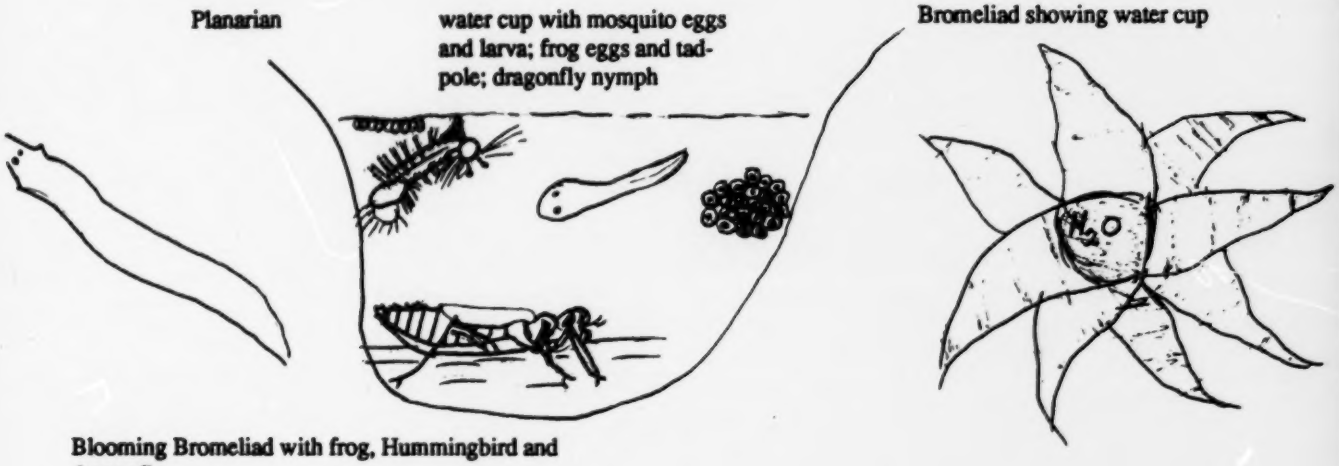
4. From blue construction paper, cut out the pattern marked "water" and then gently push it down into the top of the bromeliad to cover the top of the toilet paper core. Color and cut out the frog pattern.

Tropical frogs can be bright reds, oranges, greens, blues, and other colors. Tape or glue the frog to a bromeliad leaf. Some bromeliad leaf tips are red, orange or pink. Color the ends of your leaves, if you like.



Adapted with permission of National Wildlife Federaton from Rainforests: Tropical Treasures. NATURESCOPE, Vol. 4, No. 5. Copyright National Wildlife Federation, 1989.

342 animals have been reported as living in and around bromeliads - using the water trapped in the leaves.
Some of the species are: worms, rotifers, snails, mosquitoes, crustaceans, leeches, planarians, fresh water crabs, odonate nymphs (young dragonflies), frogs and others.


Planarian
water cup with mosquito eggs and larva; frog eggs and tadpole; dragonfly nymph
Bromeliad showing water cup
H_2O

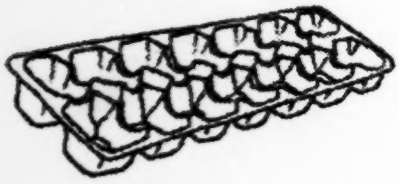
Blooming Bromeliad with frog, Hummingbird and dragonfly.

BIODIVERSITY BEANS

Objective: Students will create a model of two different types of environments, high and low diversity forests. Both are healthy, stable environments. Temperate forests, low diversity ecosystems, are effected by outside influences differently than are high diversity rain forests. The term biodiversity refers to biological diversity of a particular ecosystem. The biological diversity is the variety of species and genetic variability among individuals within species. Similar animals live in each vegetation belt or life zone by adapting to similar environmental conditions.

Materials:

- 8 dozen -sized egg cartons
- beans: pinto, kidney, garbanzo. mung, lentil, pea, lima, cordon negro, navy
- mix of beans with 10-15 different kinds of beans
- mix of beans with 4-5 different beans
- coffee can with plastic lid
- scissors
- cup measure
- 2 zip-loc plastic bags



Procedure:

1. Make the shaker by poking 6-8 large holes (large enough to pass the largest bean) in the plastic coffee can top. Mark a plastic bag as #1 and mix 1/8 cup of each of 4 or 5 types of beans in the bag. Label the second bag as #2 and mix 1/8 cup of each of 10-15 types of beans. Save the bags to repeat the activity for further explorations.

2. Place 4 egg cartons together on one side of a table for the temperate forest, and 4 cartons together on the other side for the rain forest. For the temperate forest measure 1/4 cup of beans from Bag #1 into the shaker. Shake up the beans and then shake them over 4 of the egg cartons. Distributing as evenly as possible. For the rain forest measure 1/4 cup of beans from Bag #2 into the shaker. Shake them up and shake them over the other 4 egg cartons. Distributing as evenly as possible.

3. In this simulation each type of bean represents a species, and each bean an individual in that species' population. Compare the two forests. What is similar and what is different? The number of beans should be close to the same, but the variety is greater in the rain forest. How many of the compartments in each of the forests have all of the types of beans in them? Students should develop a way of collecting data on and graphing the number of species (different beans) and the number of individuals in a species population (number of any one type of bean) in each of the two forests.

4. Analyze the bean populations in the two forests. Then introduce outside influences into the two forests and analyze those results.

• Determine the average distance between an individual of a species and its closest neighbor of the same species. Do this for all species. How would distance affect species populations? How will individuals communicate?

• Build a road through both models by removing the beans from 6 or more egg compartments in a row. What happens to the number of species in the temperate forest? in the rain forest? Which species end up on which side of the road? Are populations separated? How do students think this will affect species populations? What would happen if certain species cannot migrate over the roads to reach food, water, or others of their kind?

• Clear cut 1/3 of each forest area. What happens to the biodiversity in each model? Are any species now extinct? endangered? Would the effect be different if a hurricane or forest fire cleared an area? What are the differences between natural disasters (storms, fires, floods, hurricanes, volcanoes), and human-caused disasters (oil spills, forest fires, toxic dumping, overdevelopment, clear-cutting)?

• Select one type of bean and distribute only 10 or less of that kind in both models. to represent and endangered or threatened species. Predict and then test to see how the changes listed above would affect the "endangered bean".

• Select species with different habitat requirements, such as one that can only live on the edge of the forest, or one that can only live in the middle. Predict and then test the effects of the above changes.

• Develop tests to answer any other class questions.

Adapted from The Green Planet Teacher Workshop Packet. Museum of Science, Boston, 1993.

TASTING THE TROPICS

Objective: Students will create a feast using rain forest products. Research the origins of the plants and products used, and consider how eliminating the sources might eliminate the products from our plates.

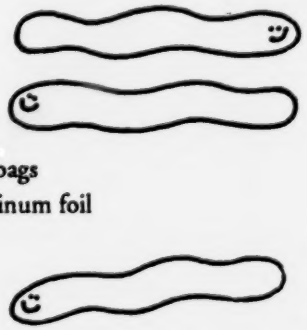
Materials:
See individual recipes

Procedure:
1. Review all recipes beforehand and decide whether they should be preapred individually or in groups; at home or in school. If groups create the foods, they should be prepared to discuss the origins of all products, and possible other uses. Students should also research the possible cultural uses of each product. When all foods are done, the class should have a display to share information before the feast begins.

2. Some of the recipe creations turn into snakes or butterflies. Those groups should prepare a display of rainforest snake or butterfly species to accompany their food display. Groups without specific species as models should have some kind of product to display, or map to locate the product's origin.

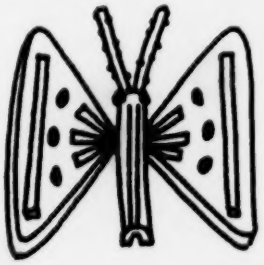
3. Individual recipes follow. Enjoy!

Slippery Snakes:
- small pan
- spoon
- bowl
- self-seal sandwich bags
- cookie sheet, aluminum foil
- scissors.



For each different color snake you'll need:
- 1 1/2 c. apple juice
- 3-oz. pkg. jello (yellow, red, green, or orange)
- 1 envelope unflavored gelatin
- 5 ice cubes

Directions:
Heat 1/2 the apple juice in pan. Add flavored gelatin and stir until dissolved. Pour remaining juice in a bowl. Sprinkle with unflavored gelatin and stir. Pour cool mixture over hot and add ice cubes. Stir until most ice is melted. Refrigerate about 20 minutes until mixture is the texture of pudding. Pour 1/2 of mixture into sandwich bag. Seal bag, leaving corner open. Cover cookie sheet with foil, and slowly squeeze jello into 2-inch squiggles. Chill 2 hours.



Butterfly Buddies
- slice of whole wheat bread per butterfly
- peanut butter
- plastic knives
- carrot and celery sticks
- chopped vegetables and nuts, pretzels, raisins.

Directions
Spread a slice of whole wheat bread with peanut butter and cut diagonally to form 2 triangles. Use a carrot or celery stick for a body and place the triangles as wings. Decorate wings with vegetables and nuts. Add pretzels for antennae and raisins for eyes.

Rain Forest Chip Dip

- 1 avocado
- 1 tablespoon lemon juice
- 1 small tomato
- 1 tablespoon grated onion
- 1/2 teaspoon salt
- 1/4 teaspoon chili powder
- 3 tablespoons mayonnaise
- dash paprika
- corn chips

Directions:

Mash a soft ripe avocado in a small bowl. Thoroughly mix in the lemon juice. Chop the tomato and add to the mixture. Blend in onion, salt, chili powder, and mayonnaise. Sprinkle with paprika. Serve with corn chips. Makes about 1 cup.

Note: If you're making the dip ahead of time, spread the mayonnaise in a layer over the avocado mixture and refrigerate. Then blend in the mayonnaise when ready to serve. This will help prevent the avocado from discoloring.

Jungle Punch

- 1 banana
- 1 cup orange juice
- 1 cup pineapple juice
- 1 can lemon-lime soda
- 1 pint lemon sherbet
- blender

Directions:

Puree a soft, ripe banana in a blender. Add orange and pineapple juice and blend. Just before serving, add the lemon-lime soda and mix well. Put a spoonful of lemon sherbet in a glass and fill with punch. Makes about 1 quart.

Spicey Cashew Cookies

- 1/2 cup shortening
- 1-1/4 cups brown sugar, firmly packed.
- 1 egg
- 1-3/4 cups flour
- 2 teaspoons baking powder
- 1/2 teaspoon each: salt, ginger, cinnamon, cloves & nutmeg
- 1/3 cup chopped cashews

Directions:

Mix shortening, sugar and egg in large mixing bowl. Measure dry ingredients and stir into shortening mixture. Stir in chopped cashews. Roll dough in 1-inch balls and place on greased cookie sheet. Flatten slightly and bake at 375 degrees for 10 to 12 minutes. Makes 4 to 5 dozen cookies.

South-of-the-Border Chocolate

- 1/3 cup cocoa
- 1/2 cup sugar
- 1 tablespoon instant decaffeinated coffee
- 1/4 teaspoon cinnamon
- 1 quart milk
- 1 teaspoon vanilla
- whipped topping
- nutmeg

Directions:

In saucepan, heat the milk until hot, but not boiling. Mix together the cocoa, sugar, coffee, and cinnamon in a small bowl. Add 2 tablespoons of hot milk to the chocolate mixture and stir until it is smooth. Blend the chocolate mixture into the remaining milk. Remove from heat, add the vanilla, and beat the mixture with a wire whisk until it's frothy. To serve, fill the cups with hot chocolate, add a spoonful of whipped topping, and sprinkle with nutmeg. Makes about 1 quart.

Choco-Banana Snacks

- 6 large bananas
- 12-oz. package chocolate chips
- 1 cup peanut butter
- toothpicks

Directions

Slice bananas into 1-inch pieces. Place one toothpick in each slide and freeze on a cookie sheet for about 1 hour. Melt chocolate chips and peanut butter together in a double boiler or in a micro wave. Dip the cold banana slices into the chocolate/peanut butter mixture to cover. Place on waxed paper until firm. Store in plastic container in freezer.

Tapioca Cream Pudding

- 1 egg slightly beaten
- 1/3 cup sugar
- 3 tablespoons quick cooking tapioca
- 1/8 teaspoon salt
- 2-1/2 cups milk
- 1teaspoon vanilla

Directions

Mix egg, sugar, tapioca, salt, and milk in a pan. Let stand for 5 minutes. Cook over medium heat, stirring constantly until mixture comes to a full boil. Add vanilla and remove from heat. Cool. Fold in sliced bananas and flaked coconut for an added surprise from the tropics. Tapioca is food made by heating the starch from the root of the manioc, a plant found in the rainforest.

Tropical Trail Mix

- 1 cup cashew pieces
- 1 cup peanuts
- 1 cup broken banana chips
- 1 cup chocolate chips
- 1 cup dried pineapple chunks
- 1/2 cup coconut flakes

Directions:

Combine the ingredients in a large mixing bowl. Makes about 2 pounds.

Note: You may want to add other tropical items if you can find them. Some possibilities include sesame seeds, Brazil nuts, dried papaya, and macadamia nuts.

RESCUE the RAINFOREST

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- Book Looking •
- In the Know •
- Knowledge Unbound •
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Volume 4 of *Science is Elementary*, published 1991-92, contained the following topics:

No. 1 "Animals/Anatomy"
No. 2 "Conservation" (out of print)
No. 3 "Newton's Laws"
No. 4 "Bottle Biology"

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Publisher: Emily V. Wade
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The Museum Institute for Teaching Science was started in 1983 as a collaboration of seven (then eleven) museums across Massachusetts for the purpose of increasing and improving the teaching of science in elementary and middle schools.

From 1986-1991 under the leadership of Frank Gardner, Executive Director of MITS, a series of successful workshops were presented and the resource publication for teachers, Science is Elementary , was developed. These activities were funded by the National Science Foundation, the federal Department of Education and private foundations and corporations. Early in 1992, the directors of the collaborating museums advised that it was time for MITS, Inc. to become a separate entity.

MITS was incorporated in June of 1992. The purpose remains the teaching of participatory, inquiry-based science, math and technology in elementary and middle schools. This goal is achieved by promoting cooperative ventures between institutions of higher learning, museums, businesses, federal and state agencies and schools. These ventures include workshops, conferences and a resource publication to promote continuing professional development for teachers, museum eductors and school administrators. During 1992 and 1993 MITS has been actively working with the Massachusetts Department of Education on their Statewide Systematic Initiative Grant from the National Science Foundation. This past July MITS ran a two week workshop for elementary teachers based on the philosophy guiding this initiative and on the topic "Our Watery World".

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Brief Brief

This issue focuses on the immense topic of water. Teachers will need to plan sufficient time for students to study various aspects of water. The topic is a good one for brainstorming and group work as curriculum areas can be integrated within a single theme. Water is relevant for students at every grade level. Local water issues abound everywhere, and only increased knowledge of the water cycle will help citizens make informed water policy decisions. Water is a topic that lends itself well to interdisciplinary study. The history of civilization is connected to water, science is connected to water; indeed all disciplines from art to poetry to music and mathematics can be linked in a study of all aspects of water. Think about a year's study on just that topic alone!

The *In the Know* section will provide some basic background information on water. The *Sciencing* section provides activities on various characteristics of water, its systems, and the attendant problems. The *Knowledge Unbound* section annotates several interesting media and software programs on water, and the *Book Looking* section provides a brief overview of non-fiction and fiction titles related to water. Please note that this is only a beginning list. This issue's *Trade Secret* involves using contour maps to find your area's watershed so students can explore the water system in their city or town—a great introduction to mathematical modelling.

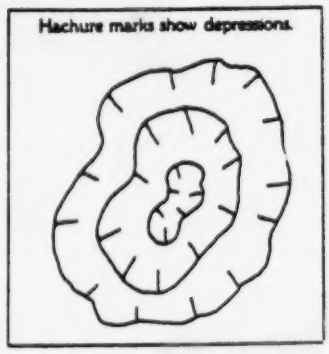
This issue's *Trade Secret* demonstrates how to make a three-dimensional model of a land area from a **topographic** or **contour map.** The U.S. Geological Service provides contour maps of any area in the United States. Obtain one of your particular area for the students to use in determining watersheds. A **watershed** is an ecological area consisting of all the land area that drains into a particular body of water. All the streams that feed into a particular river and all the land areas around those streams make up a watershed. The watershed is usually named after the river or stream that serves as the main collector of all the water in the watershed. The Columbia River watershed in the Pacific Northwest is 258,000 square miles, but watersheds can be as small as a mud puddle. Everyone lives in a watershed. All land has waterways running through it that drain into larger waterways. In most urban areas rainwater feeds into storm drains, which feed into nearby rivers or streams.

For this activity, students will first construct a model from a sample topographic map. They will then use a second sample map to define watershed areas. It is better if the teacher uses maps of the school area for both activities as this will bring the idea closer to home. The local conservation commission or the town/city engineer should be able to provide such maps. Otherwise acquire the appropriate United States Geologic Survey topo map and enlarge the section where the local watershed exists.

Contour Modeling

Pass out copies of map A from page 6 to each student. The lines are **contour lines** and show how high above sea level the land is. On this map each line represents a **change in elevation** of 20 feet (6M). The numbers represent the elevation of the earth's surface where the line passed through.

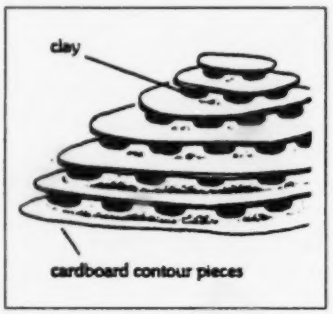
Hachure marks indicate depressions on contour maps (see diagram). Can students tell from the lines where the ground is sloping gently? Where it is steep? The greater the distance between contour lines, the gentler the slope. Now turn the map into a three-dimensional model.



- Students should work in pairs or small groups. Each group should have oaktag, pencils, scissors, crayons or markers, and clay. Give two copies of the contour map to each group.
- Cut one contour map along the 120' contour lines ***only.*** Now there are two pieces and a stream piece. Save all 3 pieces.
- Lay one of the large cut pieces on the oaktag and trace its outline. Label this piece 120'. Then cut the 140' contour line FROM THE SAME PIECE OF MAP.
- Trace this new piece on oaktag and label it 140'. Continue cutting on contour lines, tracing the pieces, and labeling each one.
- Repeat the entire procedure with the second large piece of the map original. When all pieces have been traced and labeled, cut each separate oaktag piece. There should be 12 finished pieces. Pieces can be colored to represent the different elevations: the 120' piece green, the 140' darker green, the 160' piece light brown for example.
- Using the uncut map as a guide, stack the pieces in 2 piles from the lowest to the highest elevation. Place small balls of clay between pairs to add height as they are stacked. Then

lay the stream piece (colored blue) between the two stacks. Students should be able to see the "canyon" that the stream runs through. Students can sketch the imagined terrain in such an area.

- To extend the idea further, have students use the stacks to create a working watershed model. By covering the stacks with papier mache, clay, or plaster, painted to represent real terrain, students can observe the movement of water on this land area. Once the model is dry, place it in a plastic tub so that the sides of the model are near the sides of the tub. Be sure the hills are at the same distance apart as when the "stream" piece was used. Use a small watering can to "rain" on the highest point. Where does the water go? Does it collect in the stream area? In any other areas? Are there more than one watersheds created? Why? Was the water movement what students expected? After the original model is constructed, teams of students could add additional hills to replicated a watershed.



Watershed Mapping

The next step is to look at a sample watershed map. Use Map B on page 7 or obtain one of your own area. If using a map of your own area, each student should determine the particular watershed he or she lives in. Students can create a large watershed map on mural paper which can be used for further study of the intricacies of a full water system.

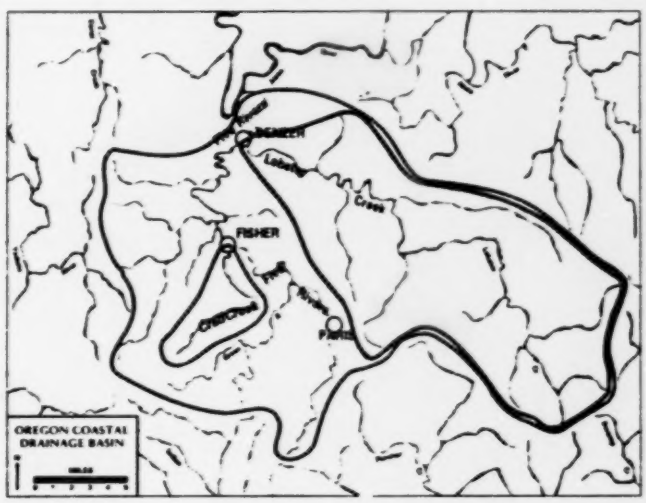
- Using the sample map, have groups of students locate a stream called Five Rivers. Also have them locate the point where Five Rivers runs into the Alsea River. The Alsea River runs into the Pacific Ocean.
- Next have students locate the Crab Creek watershed and circle it with a colored marker. Locate the Lobster Creek watershed and color it a different color. With a third color, have them draw a circle around the entire Five Rivers watershed.
- Ask: *If you lived two miles south of the town of Fisher, in which watershed would you live?* (You would live in the Crab Creek watershed which is part of the larger Five Rivers watershed.) A large watershed is made up of many smaller watersheds. Both Crab Creek and Five Rivers would be correct answers to the question. *Which watershed would you live in if you lived in Paris?* (Five Rivers). Teachers can make up appropriate questions using maps of their own areas. After discussion, ask your students to write a paragraph describing their watershed as displayed in the map.
- Students can also calculate how many miles of stream and river are in the sample map area. Using the "scale of miles" and string, follow the curving waterways to make measurement more exact. Measure each waterway and add the individual measures. How many miles of water are represented? This also makes clear the amount of water in a watershed area that can be affected by human activities. Measure the miles of waterways on a map of your own area. You may choose to have srudents make estimates of miles of waterways before they do the tracing and measurement.

Extensions

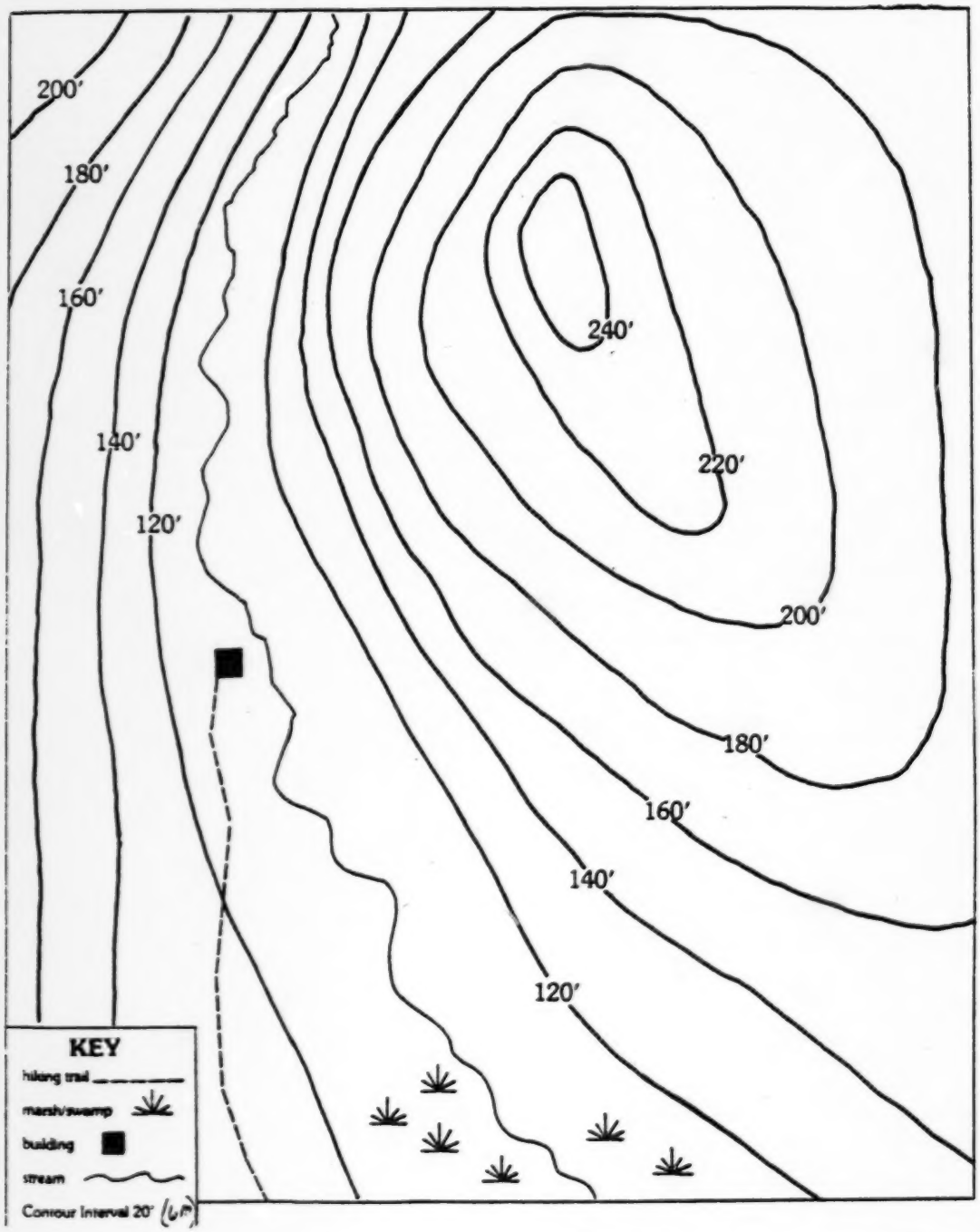
This mapping will only begin your water study. Students need to research the system that brings water into the school, or trace the path of a raindrop that falls off the school building, travels across the yard, and enters the water system. How does it get to a river or the sea? Local maps will be necessary. A trip to the waterworks is also useful in conducting research of this type. Have students brainstorm a list of the human activities that affect their watershed system. These might include actions such as discarding of oil or other wastes into a stream, clearing land (removing vegetation), or washing cars with soaps that contain phosphates (non-biodegradable chemicals). Reasearch which pollutants dissolvse in water. Then have students determine how and where these chemicals would travel in the watershed. They can do this by tracing the path from the smallest tributary in the smallest watershed as it empties into larger and larger watershed areas. Then repeat the activity using non-human influences such as heavy rains, wind, and other natural phenomena.

Investigate the history of your watershed. When was it born? What animals depend on the watershed? What Native American peoples used the watershed and how did they use it? When and why did the first European settlers come to the area? What industries were built there that depend on the watershed? Are there any interesting facts about it, myths or stories associated with it? Students can make a watershed history timeline. Contact a local water official to speak with the class on the importance of water and any area problems there may be. Have the class visit all or part of your watershed area. Study the physical and biological aspects of your watershed area. Write a poster or newspaper about your class watershed studies. Produce a panel discussion, play, or video for a local cable channel. Investigate the concept of wetlands (a year's study in itself) and how valuable they are to water and habitat resources. Invent and have the community complete a survey/inventory about knowledge of water and watersheds. Tabulate and use the results to plan a water saver campaign.

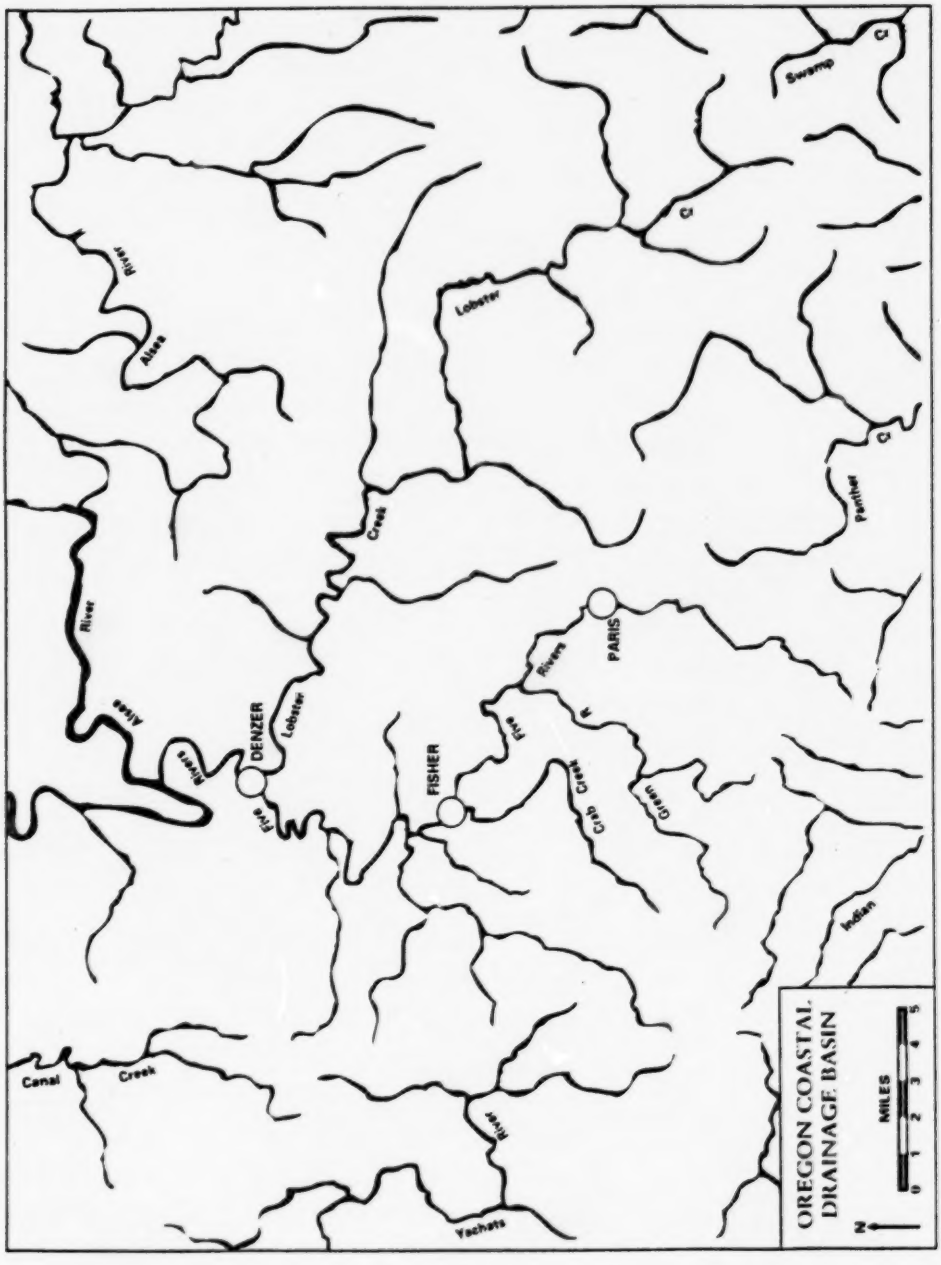
There are endless suggestions for activities. Consult your state water control agency, the departments of fisheries and wildlife and local conservation agencies for additional resources.



MAP A


200′
180′
160′
140′
120′
240′
220′
200′
180′
160′
140′
120′
KEY
hiking trail
marsh/swamp
building
stream
Contour Interval 20′ (6m)

MAP B


Swamp
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Lobster
Creek
Panther
Creek
PARIS
Rivers
N
Fork
Crab Creek
Crab
Creek
Indian
DENZER
Lobster
Creek
FISHER
Alsea
River
Alsea
River
Canal
Creek
River
Yachats
OREGON COASTAL
DRAINAGE BASIN
MILES
0 1 2 3 4 5
N

A River Ran Wild. Lynne Cherry. Harcourt Brace, 1992. Grades 2 and up. Traces the history of the Nashua River Valley in New Hampshire from the days of the Native Americans, through the industrial era and pollution, to the efforts of locals to clean up the river—a successful effort. A historical timeline and map are included.

Mariculture: Farming the Fruits of the Sea. Frances Koch. Franklin Watts, 1992. Grades 4 and up. A look at sea farming and ranching around the world.

Coral Reefs in Danger. Chrostopher Lampton. Millbrook Press, 1992. Grades 4 and up. An introduction to aquatic ecology. Coral reef biodiversity rivals that of the rain forest and is also an endangered habitat. Readings, glossary, and index are included.

Water Science. Deborah Seed. Addison Wesley, 1992. Grades 2-5. Begins with the story of water and explains scientific properties. Includes water myths and games.

Water Up, Water Down: The Hydrologic Cycle. Sally Walker. Carolrhoda, 1992. Explains each step of the water cycle. A glossary is included.

Disappearing Wetlands. Hellen Challand. Children's Press, 1992. Grades 2-5. A timely and comprehensive account of the threats to the world's necessary wetlands.

Letting Swift River Go. Jane Yolen. Little, Brown, 1992. Grades 3-6. Story of the Quabbin Reservoir and the towns flooded to create a water supply for Boston.

Powerful Waves. D.M. Souza. Carolrhoda, 1992. Grades 1-4. Part of the "Nature in Action" series. Presents the science of wave formation, the size of waves, and their destructive power. Mathematics of waves are presented simply so that readers can measure actual waves. The fact list is interesting. Glossary.

Water. Hillary Devonshire. Watts, 1992. Part of the "Science Through Art" series. Grades 2-6. Explores the science of water through interesting art activities.

Life in the Oceans: A Planet Earth Book. Norbert Wu. Little, Brown, 1991. Grades 3-7. The book takes readers on an undersea tour focusing on life, food chains, and survival. Content and index.

Loon Lake. Ron Hirshi. Cobblehill, 1991. Grades PreK-3. Young readers are invited to explore a lake habitat and the creatures dependent on the water.

Fishing At Long Pond. William T. George. Greenwillow, 1991. Grades PreK-3. A young girl learns about the pond ecosystem while fishing with her grandfather.

Oceans. M. Hoff and M. Rodgers. Lerner, 1991. Grades 4 and up. Highlights the ocean and its problems. Index, glossary, agency list, and "What Can We Do?" section.

Window on the Deep: Adventures of Underwater Explorer Sylvia Earle. Andrea Conley. Watts, 1991. Grades 5-8. Earle takes readers on dives around the world's oceans explaining the water ecosystem and its threats. Bibliography, glossary, index, and list of readings.

Riverkeeper. George Ancona. Macmillan, 1991. Grades 3-6. Photo biography of an environmentalist hired as caretaker of a New York waterway.

Follow the Water from Brook to Ocean. Arthur Dorros. Harper Collins, 1991. Grades K-3. Shows the hydrologic cycle from rain/snow to brook/stream. Examines flowing water, pollution, habitats, and erosion.

The Sea. Brian Williams. Warwick, 1991. Grades 4-8. Covers a broad range of topics on ocean technology from the creation of the ocean to weather from the sea. Glossary and index.

Rain: Causes and Effects. Philip Steele. Watts, 1991. Grades 5 and up. Provides an overview of the many ways rain affects the planet. Simple experiments included. Glossary and index.

Protecting Rivers and Seas. Kamini Khandjuir. EDC Publishing, 1991. Grades 3 and up. Explains what should be done to protect natural habitats and the species that depend upon them.

The Water's Journey. Eleanore Schmid. North-South, 1990. Grades K-3. The water cycle is explained in a picture book format.

Water Pollution. Kathlyn Gay. Watts, 1990. Grades 6 and up. A balanced discussion of effects of all types of pollution in water and how it gets there. Discusses necessary legislation and steps individuals can take to prevent pollution.

Adopting a Stream: A Northwest Handbook. Steve Yates. Univ. of Washington Press, 1989. Grades 4 and up. The book details the reasons for adopting a stream and the rewards and problems with stewardship. Citizen participation in the protection of water sources is vital. Examines water ecosystems, provides examples of successful community projects, and includes a wide variety of activities.

Rain of Troubles: The Science and Politics of Acid Rain. Laurence Pringle. Macmillan, 1988. Grades 6 and up. Discusses origin of and problems with acid rain, but also provides some suggestions for remedies to improve conditions.

The Water Planet: A Celebration of the Wonder of Water. Lyall Watson. Crown, 1988. Grades 6 and up. Coffee table-sized book of photos and essays on water; its scientific laws and the role water plays in life.

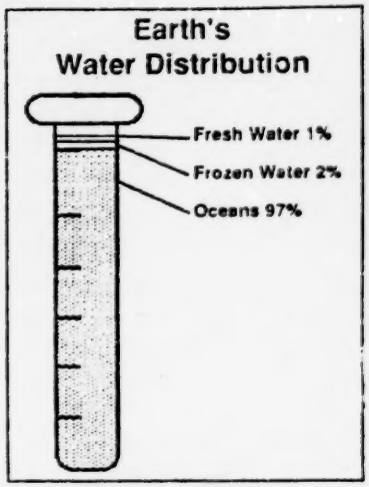
Dry or Wet? Bruce McMillan. Lothrop, 1988. Grades PreK-1. Explores a single concept through photographs of opposites. Includes language-building activities.

The Magic School Bus at the Waterworks. Joanna Cole. Scholastic, 1987. Grades K-6. Students travel on the magic bus through the clouds, into a reservoir, and out through the sink pipes. Includes charts of water facts.

This issue will focus on earth as the **water planet.** Many students are completely unaware of the nature of water and its relationship to all life on earth. In these times, no one can afford to be "water ignorant." Political decisions, monetary decisions, ecological decisions—all need to be made and all involve our dwindling usable water supply. We hope this issue will give you and your students some positive experiences with water so that future decisions about water can be educated ones.

Water. It is a word that conjures powerful images in everyone's mind, images that may be poetic or destructive. Water is strange in its composition, movements, and effect on us all. It is the most abundant liquid on earth, and the only inorganic liquid to occur naturally. We are part of a continuous liquid web that holds all life together. Our liquid planet glows like a soft blue sapphire in space. There is nothing like it in the solar system. Water ice has been detected in the tails of comets and the rings of planets, but not a drop of liquid has so far been found in the galaxy.

We are creatures of water living on a water planet. **Sixty-five percent** of our body weight is water. There are approximately **330 million cubic miles** of water on the planet; **1/10th** of the planet's mass. Some forms of life can function without air, but **none** without water. Human beings can live several weeks without food, but only a few days without water. It is amazing to note that, according to the best evidence, the amount of water at present on our globe is roughly the same amount that existed three billion years ago. Our problem today is not that there is less water, but that there is less usable or clean water. **Ninety-seven percent** of the water on Earth is salt water, and virtually unusable due to the high cost of desalinization processes. **Two percent** of the water is glacier ice-locked at the Poles. Although many have speculated about unlocking this glacier potential, it is not, so far, economically feasible to melt it down. **Less than 1%** of all water on Earth is fresh water that we can actually use. We use this small amount for drinking, transportation, heating and cooling, industry, and other things. Can your students think of other uses?

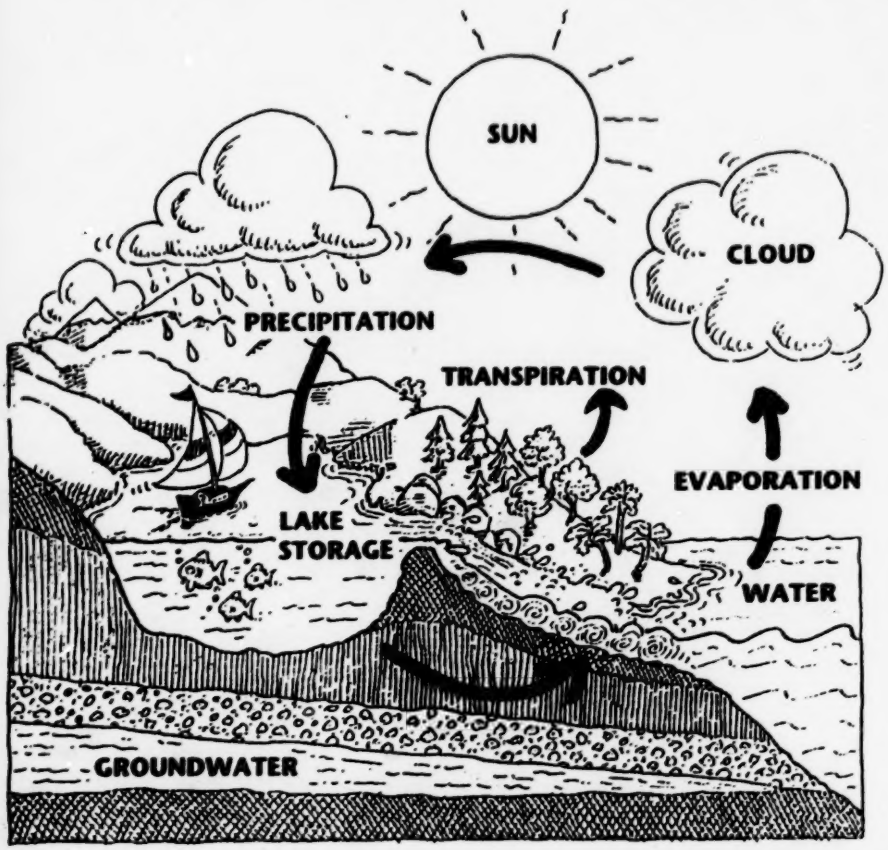


A single water molecule is made up of two atoms of hydrogen (H) and one atom of oxygen (O). That is why water is referred to as H_2O. Water is **tasteless, odorless,** and **colorless.** It is a universal **solvent,** a liquid that eventually can dissolve all other substances. It is the only substance that occurs in three states at temperatures compatible with life on earth: **solid** (ice), **liquid** (water), or **gas** (vapor). It is denser as a liquid than as a solid. Ice is frozen water that floats because it becomes less dense or lighter than liquid water. It freezes at 0 degrees Celsius and 32 degrees Fahrenheit. Liquid water is fluid, and is the most familiar form. Water vapor is always present in the air around us. When water is boiled it changes from liquid to gas and the vapor can be observed. When some of the vapor cools we see it as steam. Steam is a mini-version of clouds in the sky. Steam is formed at 100 degrees Celsius and 212 degrees Fahrenheit. The *Sciencing* section includes simple activities on water characteristics.

Water moves from the earth to the air to the earth

again through a recycling process called the **hydrologic cycle**. It changes from solid to liquid to gas over and over again. The hydrologic cycle never stops. Water keeps moving and changing around us all the time. Water **evaporates**. It travels from the earth into the air and becomes part of a cloud. Energy from the sun is responsible for changing liquid water in oceans, ponds, and other water sources into water vapor. Water vapor is also returned to the atmosphere by plants through tiny structures called **stomata** on the leaves. This process is called **transpiration** and is a major source of water vapor. Imagine how much transpiration occurs in the rain forests. Water returns to earth as **precipitation** (rain, snow, fog) due to **condensation**. The precipitation creates **runoff** that travels over the ground surface and helps to fill lakes and rivers. It also **percolates** or moves downward through openings in the soil to recharge groundwater **aquifers** underground; the **water table**. The water table indicates the level of water in the ground. Some places receive more precipitation than others. These areas are usually close to oceans or large bodies of water that allow more water to evaporate and form clouds. Other areas receive less precipitation. Often these areas are far from oceans or are near mountains. As clouds move up and over mountains, the water vapor **condenses** to form precipitation and freezes. Snow falls on the peaks.

There is more water underground than on the surface. The water we use for drinking and other purposes comes from this **groundwater supply**. Its depth is determined by the amount of water entering and leaving via the hydrologic cycle. The groundwater level rises and falls seasonally. Most **recharge** (depositing of new water) occurs from December to April, causing the water table to rise. From May to November, water is withdrawn faster than resupplied and the water table falls. In very dry years the water table is lowered even more. Shallow marshes and ponds may go dry. In a series of wet seasons the table rises. This is

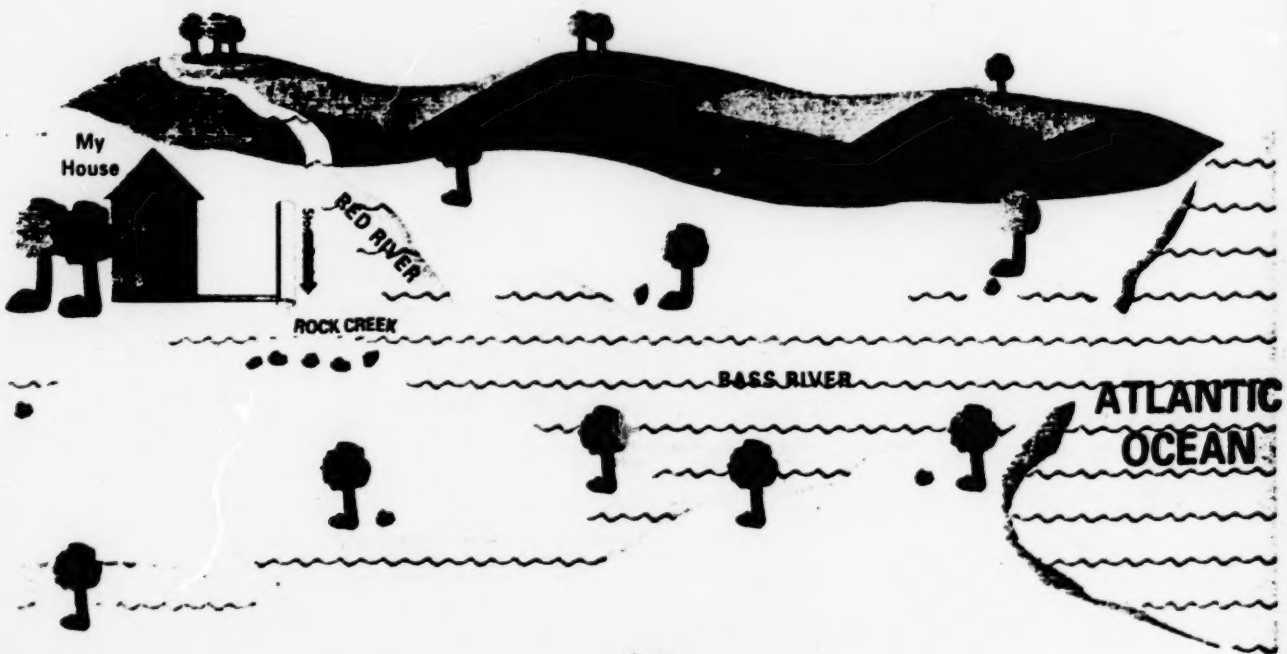


reflected in higher pond levels. Every day millions of gallons of fresh groundwater are discharged to the ocean through river drainage.

Everyone lives in a **watershed.** A watershed is the area of land from which all water drains to a given point. Most watersheds fall between hills or mountainous areas from which the water flows down to a central river area, which is usually at the center of the watershed. A watershed can be as small as the area around a puddle, or as large as the area draining to the Mississippi River. The rivers, the hillslopes, the mountaintops, and the flood-formed bottom lands are all part of the individual watershed. It is a functioning, closed system. If a forest that intercepted and transpired a portion of water falling on the system is removed, the energy flow through the watershed is changed and the shape of the hillside and stream channels within the watershed must adjust.

There are many threats to our water supplies. **Contamination** by pesticides, chemicals, improperly treated sewage, and toxic industrial wastes pollute industrial water. **Acid rain** caused by sulfur dioxide and carbon monoxide entering the atmosphere from factory discharge and automobile exhaust is killing many of our lakes and damaging the environment. Supplies of **groundwater** are being depleted faster than nature can replenish them due to increasing demand by an increased population. **Natural wetlands** have been filled in and built over, causing flooding and erosion, destroying natural habitats, and preventing nature from resupplying aquifers through these natural sponges. **Agricultural techniques** use water inefficiently. Increased public knowledge and awareness is necessary if the problems are to be solved.

How does groundwater get polluted? Some contaminants are toxic, colorless, and odorless. When they are deposited on land, these sub-



stances may find their way into an aquifer by dissolving and moving with the water. When some pollutants combine in the environment, they become even more dangerous. This increased effect is known as a **synergistic reaction**, common in the development of acid rain and air pollution. The leaching of hazardous chemicals into the groundwater results in an underground **plume** of pollution which can spread as the water supply moves through the aquifer. Pollution from the atmosphere may also taint groundwater. On most continents, the groundwater is now too polluted to drink. The North American population has shown significant growth for less than 400 years, while Europe, Africa, and Asia have had dense populations for thousands of years. Population growth and density pose a grave threat to water quality.

A closer look reveals there are **aquatic habitats** utilized by many species all or part of the time. Vernal or spring pools, ponds, streams, rivers, lakes, swamps, bogs, marshes, potholes, wet meadows, and oceans are all home to multitudes of creatures. It may be interesting for students to research the various aquatic habitats, their inhabitants, their role in the water system, and the threats to their continuation. Wetlands alone would require a year of study. Water is also powerfully destructive. Erosion, floods, tidal waves, glaciers, and avalanches are all part of water's power. Older students may also wish to research this aspect of water.

Leonardo da Vinci spent much of his time observing and experimenting with water. It fascinated him. In one of his notebooks he wrote extensively about water: "Water is sometimes sharp and sometimes strong, sometimes acid and sometimes bitter, sometimes sweet and sometimes thick or thin, sometimes it is seen bringing hurt or pestilence, sometimes health-giving, sometimes poisonous. It suffers change into as many natures as are the different places through which it passes. And as the mirror changes with the color of its object, so it alters with the nature of the place, becoming: noisome, laxative, astringent, sulfurous, salt, incarnadined, mournful, raging, angry, red, yellow, green, black, blue, greasy, fat, or slim. Sometimes it starts a conflagration, sometimes it extinguishes one; is warm and is cold, carries away or sets down, hollows out or builds up, tears down or establishes, fills or empties, raises itself or burrows down, speeds or is still; is the cause at times of life or death, or increase or privation, nourishes at times and at others does the contrary; at times has a tang, at times it is without savor, sometimes submerging the valleys with great floods. In time and with water, everything changes."

The Great Ocean Rescue is a CD-ROM/Macintosh interactive simulation that allows students to take a cooperative voyage to the ocean floor. Students assume roles in solving problems. Includes a videodisk, software, teacher's guide, resources, and student booklets. Requires MAC plus or better. Grades 5 and up.

Tom Snyder Productions
80 Coolidge Hill Road
Watertown, MA 02172
(800) 342-0236

The Earth's Water allows students using this program to learn about the water cycle, ground water, streams and rivers, lakes and ponds, the oceans, and marine life. Apples II's, IBM, and Macintosh. Grades 7-12.

Water is an interactive tutorial on health issues, sources of pollution (manufacturing , agriculture, recreation, sewage [e.g. Boston Harbor], and scarcity. In the simulation *How Much Water Can I Afford?* students play one of three different roles: city dweller, small farmer, or factory owner. Each needs to buy a certain amount of water. Their choices are based on the cost of water, the quantity they need, and the alternatives they can find in order to use less water. The results of their choices can be seen in the effects on the state as a whole: does the cost of water go up or down? Apple II's, Macintosh, or IBM PC 3.5. Grades 6 and up.

Pond Ecology demonstrates the delicate balance within the pond ecosystem and how it can be upset by both natural and human-made influences. Apple II's for grades 6 and up.

Oceans and **Water** allow students to explore oceanography and the basics of water science, including the composition of water. Apple II's. Grades 3-6.

The above items are available from: Queue, Inc.
338 Commerce Drive
Fairfield, CT 06430
(800) 232-2224

Introducing Oceanography is a live action/enhanced video. Q&A sessions present students with timely facts and theories about ocean topography, wave and tide movements, and marine life. Post-viewing materials include transparency masters and other take-home work to involve parents in their child's study. The set includes two VHS cassettes, 36 skill sheets, 10 transparency masters, and teacher's guide. The program is also available in a set of six filmstrips with cassettes, skill sheets, transparency masters and guide: Exploring the Oceans; The Changing Ocean Floor; The Study of Seawater; The Action of Currents, Tides and Waves; Ocean Life: The Open Sea; Ocean Life: Life Cycles in the Sea. Grades 4-8.

Society For Visual Education, Inc.
Department JT
1345 Diversey Parkway
Chicago, IL 60614-1299
(800) 829-1900

The Water Cycle allows students to observe precipitation, condensation, and evaporation. This interactive software shows how water evaporates, forms clouds, and rain falls again. Apple II's. Grades 2-6.

Lawrence Productions, Inc.
1800 South 35th Street
Galesburg, MI 49053
(800) 421-4157

A Field Trip into the Sea introduces students to the magnificence and diversity of the kelp forest and a rocky shore habitat. Students can click on any plant or animal to find its name. They can also zoom in for a closer look and find hidden creatures, and link to find an animal in another setting. By using the interact data table or

Field Guide students can get detailed information about more than 50 species. The integrated ***Food Chain Activity*** challenges students to identify the predator/prey relationships in the kelp forest. Includes a copy of the Kelp Forest Nature Book and a teacher's guide. Apple II's and Macintosh. Grades 4-8.

Exploring Tidepools is designed to build students knowledge of life cycles at differen tidepools levels. Students are encouraged to observe and take "on-screen" notes as well as build their own tidepools. By exploring and moving objects, students learn about predator/prey relationships and discover hidden life forms within the scenes. Special "field guides" included in the program make it easy for students to identify the plant and animal life by common names and phylum. Includes teacher's guide. Apple II's. Grades 4-8.

The Worlds Below is a two-part video that begins with six lyric compositions of sea photography accompanied by music. Exotic images of the coastal ocean habitat are shown as students move from the crashing surf deeper into the kelp beds. The second part replays the same video footage, but this time with solid scientific narration explaning what has been witnessed. VHS. (From a *3-2-1 Contact!* show.) Grades 4-8.

Boy Under the Ice examines the true story of a cold December day, when 11 year-old Alvaro Garza fell through ice that covered a river in Minnesota. Before rescue workers could find his body and pull him from the icy water, forty minutes had elapsed in which he could not breathe. Doctors were surprised to find that the boy "preserved" under the ice suffered minimal damage. The video lets students investigate the science behind the news—how the human body tries to protect itself in extremely cold situations. VHS. Includes a teacher's guide. (From a *3-2-1 Contact!* show.) Grades 4 and up.

Down the Drain explores the fact that there is only so much water and it has been recycling for years. The water we drink today is the water dinosaurs drank. Students travel in the water cycle to find out how water gets dirty and clean, and what we can do to help conserve and preserve it. Includes teacher's guide. VHS. (From a 3-2-1 Contact! show.) Grades 4-8.

Coral Kingdom uses audio and photographic images to help students investigate coral reefs. Includes simulations, slide shows, and a sea life catalog of species inhabiting the reef. Macintosh with CD-ROM. Grades 6 and up.
All of the above items are available from:

WINGS for Learning/Sunburst
1600 Green Hills Road
P.O. Box 660002
Scotts Valley, CA 95067-0002
(800) 321-7511

Cleanwater Detectives is an ecology-based simulation in which students become clean water detectives investigating various water pollutants. They learn some of the techniques and procedures for setting up and conducting investigations. Through research and testing, students gather data about streams, rivers, and lakes in a county. As they find the pollution and its source, they bring the problem to the attention of the proper authorities and recommend a solution. Apples. Grades 3-8.

MECC
6160 Summit Drive North
Minneapolis, MN 55430-4003
(800) 685-MECC

Our Watery World is a video geared that introduces the topic of water. The package includes a program summary, vocabulary list, pre and post-viewing activities, hands-on demonstrations, and student sheets. Grades K-5.

Agency for Instructional Technology
Bloomington, Indiana 47401

Water: The Resource That Gets Used & Used & Used for Everything!, and **How Do We Treat Our Wastewater?** are posters designed to be used together. Activities and information are on the back. There are versions for primary and middle grades; specify when ordering. Cost is $5 each, bulk prices available. Prepayment is required.

American Water Resources Association
5410 Grosvenor Lane, Suite 220
Bethesda, MD 20814

Water Wizards (Grades 3-4), **Water Watchers** (Grades 6-8), and **Water Wisdom** (Grades 9-12) are illustrated manuals with activities, student sheets, and background information. First two manuals are free, and the third is free within MWRA service areas, or $10 elsewhere. Other materials are available.

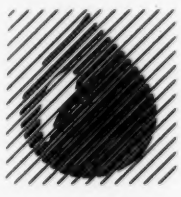
Massachusetts Water Resources Authority
School Programs
Charlestown Navy Yard
100 First Avenue
Boston, MA 02129

What's In Our Water? is a hands-on kit geared for grades 4-6, the results of experiments from which can be shared over the National Geographic Kids Network.

National Geographic Kids Network
National Geographic Society Educational Services
Washington, DC 20036
(800) 368-2728

To the Last Drop is a board game to teach students about water conservation, pollution and the hydrologic cycle. Publication #4-H778 costs $10. Indiana residents add 5%.

Purdue University
Media Distribution Center
301 S. Second Street
Lafayette, IN 47905-1092



Water in Your Life is a kit featuring a video, poster, and information. Send request on school stationery stating number and age of students to:

Communications Dept.
EcoWater Systems
PO Box 64420
St. Paul, MN 55164

Acorn Naturalists offer science field study kits and teacher sourcebooks for Grades K-6. Sample titles include: creeks/ponds, tidepools, and oak woodlands.

Acorn Naturalists
17300 E. 17th Street
Tustin, CA 92680
(800) 422-8886

The **American Water Works Association** offers several units including sourcebooks, software, and posters. *Water Can Be Fun, Water Conservation,* and *Water Works* are available. They also offer a simple *Water Quality Kit for Tap Water* with a teacher's guide.

American Water Works Assoc.
6666 W. Quincy
Denver, CO 80235

Celestial Arts offers a glow-in-the-dark poster of the ocean floor.

Celestial Arts
PO Box 7327
Berkely, CA 94707
(800) 841-2665

Math/Science Nucleus offers a *Water Cycle Curriculum* with student sheets and activities, and a teacher's guide. A lab kit is also available.

Math/Science Nucleus
3710 Yale Way
Freemont, CA 94538

The **US Geological Survey** offers contour and topographical maps, and reports on water use, and hydrologic events in the United States.

USGS
PO Box 25425
Denver Federal Center
Denver, CO 80225

The Water Planet is a hands-on guide for grades 5-10 on all aspects of water science. Order #PB-76, 1989 for $16.50.

National Science Teachers Association
1742 Connecticut Avenue, NW
Washington, DC 20009

The **Mingan Island Cetacean Society** offers two teacher's guides and student activity kits. *Marine Science Activities on a Budget* and *How to Build an Inflatable Whale* are both geared for K-12.

MICS
20 Moynihan Road
South Hamilton, MA 01982

The **Water Environment Federation** offers student activities on surface water, wastewater treatment, groundwater, and water conservation.

Water Environment Federation
601 Wythe Street
Alexandria, VA 22314-1994
(800) 666-0206

CHEMetrics offers water quality test kits which test for 40 parameters. Catalog and demo kit are available. Educators get a 30% discount. Request on school letterhead.

CHEMetrics, Inc.
Route 28
Calverton, VA 22016
(800) 356-3072

Catalog of Gulf Coast Marine Specimens is available for use in the classroom and aquarium. A list of publications is also available.

Gulf Specimen Marine Laboratories Inc.
PO Box 237
Panacea, FL 32346

The **National Association of Conservation Districts** offers *Land of Life*, an activity poster about soil for K-2 (17 cents each), *Water and Me*, a K-2 coloring and activity book (30 cents each), *Amazing Soil Stories*, a natural resource activity book in comic book format (75 cents each/ teacher's guide $1.75 each), and a graphic *textbook cover* with conservation trivia on the back (28 cents each for up to 99 copies/25 cents each for 100-500 copies).

NACD Service Center
PO Box 855
Leaque City TX 77574-0855

The Ocean: Consider the Connection is a K-8 activity book ($8.95), and **Sea Turtles of the World** is a color identification poster ($4). Include $2.25 P&H.

Center for Marine Conservation
1725 Desales Street, NW
Washington, DC 20036

Delta Education offers OBIS (Outdoor Biological Instructional Strategies) packets featuring teacher information and investigative student activities. Units include: *Aquatic Animal Behavior, Breakwaters and Bays, Ponds and Lakes, Streams and Rivers*, and *Seashore*. The packets cost $18 each. They also offer a Pond Field Guide. The *Water Cycle Model* helps students visualize the water cycle in action. Includes 10 study cards.

Delta Education
PO Box 950
Hudson, NH 03051
(800) 442-5444

PO Box 950
Hudson, NH 03051
(800) 442-5444

Interact presents integrated simulations that involve students in all aspects of their learning. *Oscar's Ocean* simulates a scientific expedition beneath the sea to map the floor and sample sea life. Each unit costs $26, and includes teacher's guide and student activities.

Elementary Simulations Interact
PO Box 997
Lakeside, CA 92040
(800) 359-0961

The **National Council for Geographic Education** offers *Water in the Global Environment,* investigating water-related issues. Grades 8 and up. The book costs $7 including postage.

National Council for Geographic Education
Leonard Hall 16A
Indiana University of Pennsylvania
Indiana, PA 15705-1087

The **Marine Science Center** offers the *Puget Soundbook* explaining ways to preserve the environment. Adaptable nationally. Guide costs $3.95 including postage. Discounts for multiple copies are available.

Marine Science Center
PO Box 2079
Poulsbo, WA 98370

Discovery Scope is a unique tool that allows students to examine water creatures, soil samples, or other objects on site in the field. The scope costs $35 and is student-hardy for all age levels. With every order, the company includes the booklet *Discovering Wetlands with Discovery Scope.* The booklet costs $1 without the scope. Other booklets available include *Exploring with a Hand-Held Microscope, Imagining a Hidden World, Micro-life Parts I and II.*

Discovery Scope, Inc.
P.O. Box 607
Green Valley, AZ 85622
(800) 398-5404

Dolphin Log is a magazine which introduces children ages 7-15 to marine biology, ecology, and natural history. Cost is $10 for 6 issues.

Dolphin Log
Cousteau Society
930 W. 21 Street
Norfolk, VA 23517

Elementary School Science for the 90's is a book on how to initiate, teach, and evaluate a school science program. Cost $13.95. Request St.# 611-90119.

Association for Supervision and Curriculum Development
1250 N. Pitts Street
Alexandria, VA 22314-1403

Connections: Science by Writing is a teacher's guide that teaches science and literacy to grades 5-9, includes student handouts and more than 50 activities. Send $16.50 plus $3.50 S&H. Also request brochures of other publications.

Serin House Publishers
5905-D Clark Road
Suite 160
Paradise, CA 95969

Hands on Recycling is a kit with samples of plastic from each of five recycling steps, which helps grades 2-8 students understand the recycling process by touching and seeing. Cost is $9.95 plus $2.50 S&H.

Hands on Recycling
8901 Olympic Drive
Bridgewater, IL 60455

E for Environment is an annotated bibliography of children's books with environmental themes listing 517 fiction/nonfiction titles published within the last 10 years. Most books PreK-4. Cost is $9.95.

R.R. Bowker
PO Box 31

New Providence, NJ 07974
(800) 521-8110

Intellimation's Library for the Macintosh is a software catalog.

C. Blohm and Associates
7402 Quail Run
San Antonio, TX 78208-3129
(800) 3-INTELL

Network for Success is a newsletter for science and math teachers interested in summer scientific work experience programs.

Kaye Storm
c/o Deskin Research Group
2270 Agnew Road
Santa Clara, CA 95054

Culturally and Linquistically Diverse Students is a catalog of resources for teaching bilingual or culturally diverse students.

Communication Skill Builders
3830 E. Bellevue
PO Box 42050
Tucson, AZ 85733

Teacher's Packet of Geologic Materials and **Selected Packet of Geologic Teaching Aids** both contain pamplets and information sheets for K-12 teachers.

US Geological Survey
582 National Center
Reston, VA 22092.

1992 Early Childhood Software catalog lists resources as well as information on selecting and implementing computer software into pre K -3 classrooms. Edmark

PO Box 3218
Redmond VA 98073-3218
(800) 426-0856

Educational materials are available on plastics recycling and plastics in the waste stream.

Partnership for Plastics Process Education Program
1275 K Street, NW
Suite 400
Washington, DC 20005
(800) 2-HELP-90

Dover Publications offers a catalog of more than 500 educational children's books, most of which cost between $1 and $4.

Dover Publications
Dept. A263
31 E. Second Street
Mineola, NY 11501

Recycling: Do it Today for Tomorrow is a brochure on plastic recycling.

Amoco Chemical
200 E. Randolph Drive
Chicago, IL 60601

There's More to Our Lunches Than We Think: A Curriculum on Solid Waste is geared for grades 5-8 and is intended to make students more aware of their habits a consumers. Cost $1.

J.R. London
49 Woodlawn Drive
Old Saybrook, CT 06475

Activities for Teaching K-6 Math/Science Concepts is a monograph of classroom-tested activities (42 reproducible pages, $7.50). **Problem Solving with Number Patterns** is an activities monograph($9.50). **Science and Mathematics Education for the Year 2000 and Beyond** is a look at the future with suggestions for directions to take ($7.50). And **Microcomputers for Teachers** has applications for science and mathematics ($7.50).

School Science and Mathematics Association
126 Life Science Building
Bowling Green State University
Bowling Green, OH 43403-0256

World Resources is a teacher's guide with current information on global environmental trends and conditions. Cost $5 plus $3 shipping.

WRI Publications
PO Box 4852

Hampden Station
Baltimore, MD 21211

Insect Identification Study Guide is a book with detailed information on selected insects and a concise reference. Cost $5.95 plus $1.05 S&H for each book. Checks are made payable to Y.E.S.

Young Entomologists' Society
1915 Peggy Place
Lansing, MI 48910-2553

Risk Taking in Learning K-3 is a book to help teachers encourage students to take risks that lead to growth, active learning, and change. Cost $9.95.

NEA Professional Library
PO Box 509
West Haven, CT 06516
(800) 229-4200

A Guide to the Planning and Development of Outdoor Classrooms is a manual on developing outdoor learning sites. Cost is $5. (Free to MI teachers).

Missouri Department of Conservation
Education Section
PO Box 180
Jefferson City, MO 65101-0180

Sample copy of **Birds, Bats and Butterflies** a leaflet describing activities and resources for teaching environmental issues to children.

Roger Tory Peterson Institute of Natural History
110 Marvin Parkway
Jamestown, NY 14701

Suggestions for Incorporating Forestry into School Curriculum covers grades K-12.

Forest Service
US Department of Agriculture
14th & Independence Avenue, SW
Washington, DC 20250.

Exploratorium To Go: Gifts and Learning Tools is a resource catalog including publication games, science kits, and posters on many issues.

The Exploratorium Store
3601 Lyon Street

San Francisco, CA 94123
(800) 359-9899

Snakes, Snails, and History Tails: Building Discovery Rooms and Learning Labs at the Smithsonian Institution is an illustrated guide to creating and operatingdiscovery rooms. Cost is $10. Discounts available for orders of 10 or more copies.

Association of Science-Technology Centers
1025 Vermont Avenue, NW
Suite 500
Washington, DC 20005-3516

Touching the Future: Teaching Strategies for K-12 is a booklet describing seven winning proposals to the Business Week/Challenger Seven Fellowship Awards. Send request on school stationery.

Charlotte K. Frank, Vice President
Research and Development
Macmillan/McGraw Hill Publishing Company
1221 Avenue of the Americas
New York, NY 10020.

Seed grants, consisting of flower, vegetable, and herb seeds, and a **Green Earth Education Kit** are available for environmental education programs, to create new parks and community gardens, or to grow food for the hungry. The most outstanding projects will be selected for national awards. Send SASE for application.

America the Beautiful Fund

Get a free single copy of **Resource Guide to Earth Science** which includes activities, illustrations, and resource suggestions. Request on school letterhead.

Scott Stepanski
Education Department
Academy of Natural Science
1900 Ben Franklin Pkwy
Philadelphia, PA 19103-1195

The **Mathematical Association of America** offers a publication catalog.

Mathematical Association of America
1529 18th Street, NW
Washington, DC 20036

Obtain a free single copy of **Map Projections**, a poster showing a woodcut depicting Geradus Mercator, the 16th century cartographer who designed the best-known map projection. The reverse side shows 18 different map projections and gives information on each.

Books and Open-File Services Section
US Geological Survey
Federal Center
Box 25425
Denver, CO 80225

Eco Clip Art for Educators is a collection of 48 computer clip art files with an environmental focus appropriate for curriculum materials, newsletters, flyers, or brochures. Designed for the Macintosh, the clip art is ready to be placed into a page layout program or compatible word processor. Included with the disks is a catalog of images for easy selection and instructions for use. Cost is $12.

SSU Academic Foundations
Eco Clip Art
Energy Center
Sonoma State University
Rohnert Park, CA 94928

Environmental Respect features K-12 activities from Safari Club International, a nonprofit conservation education group. The guide assists teachers in setting up programs promoting respect for the outdoors. Send $5.

Safari Club International
4800 W. Gates Pass Road
Tucson, AZ 85745

Wetlands Benefits: The Potential for Wetlands to Support & Maintain Development is a useful source describing the benefits that wetlands provide to society in easily understood text. By Davies, J. & Claridge, C.F. (Eds.) 1993 AWB Publication No. 87. $15. Available from:

Wetlands for the Americas
Manomet Bird Observatory
P.O. 1770
Manomet, MA 02345

The Shorebird Education Project in cooperation with the US Prairie Pothole Joint Venture of the North American Waterfowl Management Plan produces materials free of charge. 1992 & 1993 • **Protecting Prairie Potholes Saves Shorebirds (brochure)** • **Color Poster** • **Shorebirds of the Prairie Potholes: Educational Fact Sheet** • **Animal Supoerheroes: Children's Newspaper**

Wetlands for the Americas
Manomet Bird Observatory
P.O. 1770
Manomet, MA 02345

A DROP IN THE BUCKET

Objective:

Students will observe the characteristics of a water drop. They will explore the **adhesion, magnification,** and **cohesion** or **surface tension** (proper vocabulary is unnecessary) properties of water through simple models. Water is made up of two colorless, odorless elements: **oxygen** and **hydrogen.** A water **molecule** contains two atoms of hydrogen and one atom of oxygen. One drop of water contains 2 million, quadrillion molecules (2,000,000,000,000,000,000,000.)

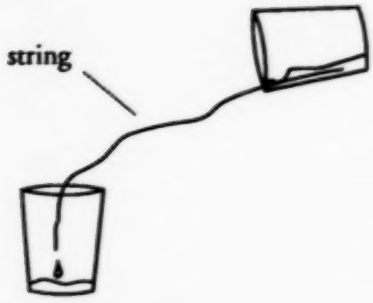
Materials (per student) :

- water
- eye dropper
- waxed paper
- masking tape
- small glass
- 100 paper clips
- oak tag
- stapler
- permanent marker
- hand lens
- writing sample
- paper towels
- small amount liquid detergent
- 2 small paper cups
- 14" piece 100% cotton string

Procedure:

1. On a small piece of waxed paper have students place **one drop** of water. They should then observe and sketch the drop from all angles. What do students notice about the shape? size? color? scent? feel of the drop? Add another drop to the first. What happens? Does it change its shape? Does anything change? (It just gets larger.)
2. Students should then try moving the two-drop drop around the waxed paper. How does the water move? Does it slide and stretch out, but not come apart? Add several more drops to the first to increase the size. Try moving the drop around. Can the drop be stretched out? Why does it hold together? See how far a 10-drop drop of water can stretch. If tiny drops of water separate themselves, move them close together and watch what happens. Water sticks to itself due to cohesion; water molecules attract each other.
3. Try sliding the 10-drop drop over some print. What happens? The water drop acts as a magnifier and enlarges the letters. Water drops are in the shape of **convex lenses** and so have **magnification** properties. If students cut two 4" squares of waxed paper, place a 20-drop drop on one piece, and then use masking tape to tape the two squares together **loosely** (like a water drop sandwich), they will have created a simple hand lens.
4. Using a rectangular piece of oaktag and a permanent marker, have students draw a long curving pathway. Staple waxed paper across the "maze". Drop a 5-drop drop of water near one end of the maze and have students try to move the drop from one end to the other by manipulating the oaktag. Students may want to create more intricate mazes. What can be observed about water's behavior? Try drop races using drops colored with food coloring for the different entrants. Can more than one maze be on the same piece of oaktag and still be manipulated? How do the waterdrops act? What controls the direction of the water flow?

5. Next, have students fill the small glasses with water, as close to the top as possible. Watching the glass from the side, carefully place a paper clip on the water's surface. It should float. The paper clip floats because water molecules cling together and form a "skin" which supports the clip. The water "clings" to the paper clip and appears to "climb" over it, because water is also attracted to other substances; the property of **adhesion**. If one drop of liquid detergent is added to the water, the **cohesion** or **surface tension** is reduced and the clip will sink.
6. A second experiment demonstrates how surface tension allows water to expand and make room for additional water **displaced** by small objects. Refill the glass as full as possible without allowing overflow. When the glass appears full, use the dropper to continue adding water, a drop at a time. Estimate how many drops can be added this way before the glass overflows. Record the answer and then re-test. Add that number. Did the water spill out? How many drops can actually be added before the water spills out?
7. Refill the glass to the top again. Estimate the number of paper clips that can be added to the glass. Record the answer and then test. Add paper clips until the water spills. Observe from the side to see the water "mounding" up over the sides of the glass. The surface tension allows water to expand over the rim and make room for tiny amounts of water displaced by the paper clips.



8. For a final experience of adhesion, soak the string for 10 minutes in one small paper cup half-filled with water. Then hold the string tightly between the filled paper cup and the empty paper cup. Make sure that the string touches water at all times. Carefully tip the filled cup until the water begins to "pour" down the string into the empty cup. Students may have to practice a few times but eventually not a drop will spill. Why? The water on the soaked string "clings" to the water poured over it. What is that property called?

Adapted from Beverly Maffei, *Science is Elementary.* MITS, Inc. 1993.

WATER HERE, WATER THERE...

Objective:

Students will explore all phases of the water cycle through two simple water cycle models. As water **evaporates** it becomes invisible. As the water vapor cools (loses heat energy) it condenses and returns to a liquid state.

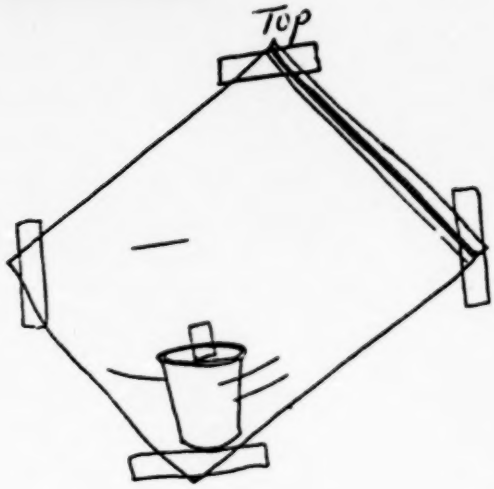
Materials (per student):

- one quart size zip-loc type bag
- one 3.5 oz. clear, plastic cup
- water
- masking tape
- permanent marker
- mayonnaise-size jar with lid
- small stones; potting soil
- small forest plants such as mosses, ivy, or baby ferns
- second large bottle cap
- thermometers (optional)

Procedure:

Model One

1. Review the water cycle using information from *In The Know.* Do not discuss the appropriate vocabulary: evaporation, condensation, precipitation, and accumulation (in the natural cycle where does water accumulate?) until after the experiment. Let the students describe it in their own words.
2. Pass out a baggie, cup, and piece of tape to each student. Place approximately 2 ounces of water in the cup and mark the water line with a permanent marker. Hold the bag diagonally (like a diamond) and tape the cup to an inside corner to prevent spilling. Close the bag tightly and tape it diagonally to a window in a warm, sunny spot. What do students hypothesize will happen to the water in the cup? Record all opinions on a sheet of newsprint.

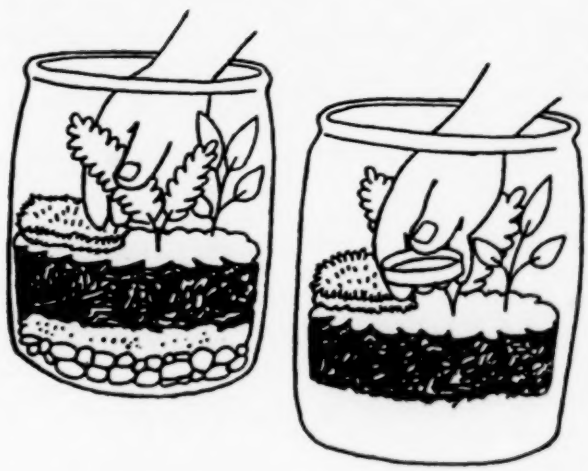


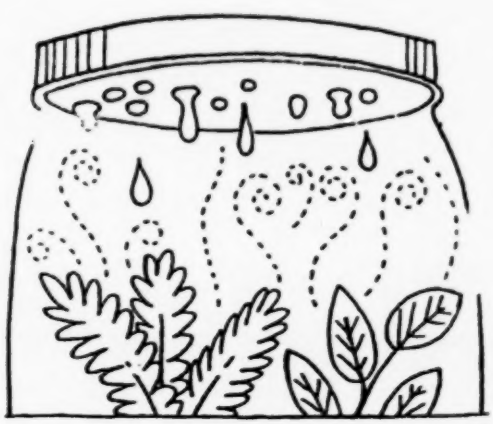
3. Water **evaporates** from the cup with the addition of heat energy from the sun, as it does from oceans, other water bodies, and leaf **transpiration.** It then **condenses** on the sides of the bag as it does in clouds. By tapping the bag students can make it "rain", or **precipitate.** Water **accumulates** in the bottom of the bag as it does in lakes, rivers, and groundwater. If you have small thermometers, the process could be repeated by putting a thermometer in the baggie.
4. Record what happens over a four-day period. Use a data collection sheet similar to the sample shown on page 26. How does the place where the bag is located affect the amount of water collected in the bottom of the bag? Experiment with different locations. What would happen over a month? If you are using thermometers, how does the site relate to temperature change?
5. Perform the same experiment again using salt water. This is one method of desalination, or separating salt from water. Try using different liquids such as milk, soda, or vinegar. Add food coloring to the water to represent contaminants. How does it move through the cycle?

Model Two

1. Pass out the jars to each student to make a water cycle terrarium. Layer in the bottom of each jar: stones to 1/4 inch deep; sand just to cover the stones; and soil about 4 inches deep. Create a nice arrangement of the plants and bury the roots in the soil. Fill the second cap with water to create a terrarium "lake" (water source). Tightly screw on the lid.
2. Find a shady place to keep the terrariums. Water will condense on the lid, precipitate on the lake and forest, evaporate into the air and then repeat the process. How long can terrariums of this size maintain the water cycle with a static amount of water in the system? Record data and graph results for all terrariums. What factors in individual terrariums made them more or less able to sustain the system? Why?

NOTE: Whichever model is used, return to the students opinions recorded before the activity and ask what changes they would make now. This is a good way to discuss the difference between fact (based on observation) and opinion. In science both fact and opinion are useful, but one must recognize which is which. We test our opinions to get the facts.

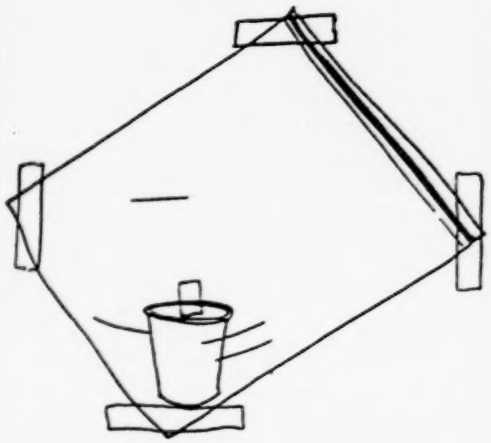




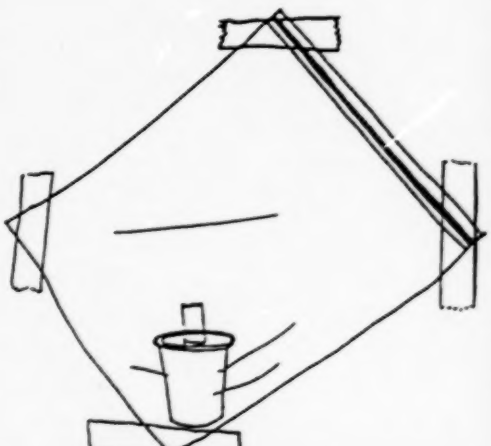
Adapted from *Water, Precious Water Book A.*
Copyright AIMS Foundation, 1988.

Sample Data Sheet

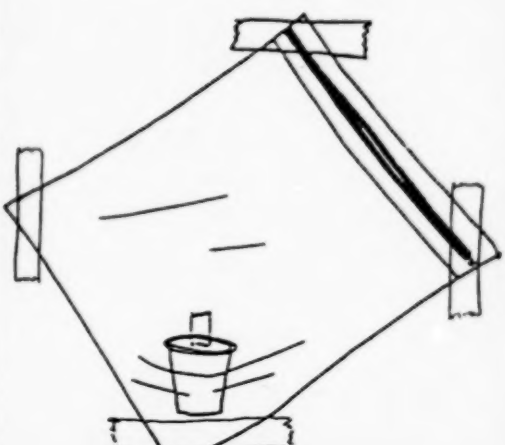
1. Draw a picture at the beginning of the experiment.



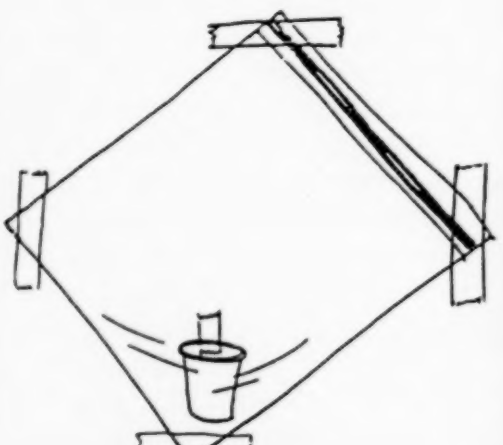
2. Draw picture after <u>two</u> hours.



3. Draw a picture on <u>Day 2</u>.



4. Draw a picture on <u>Day 4</u>



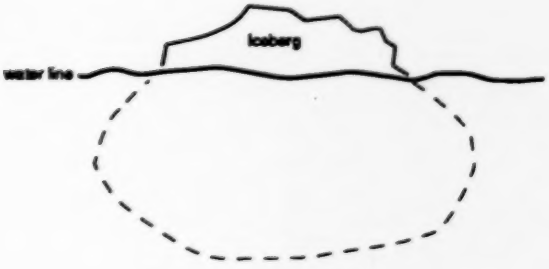
THE ICEBERGS COMETH

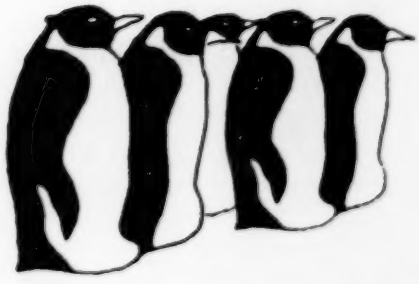
Objective:

Students will create an iceberg and then observe its behavior in water. Both polar ice caps contribute huge icebergs to the oceans. The ship, the Titanic, fell prey to one of them.

Materials:

- plastic sandwich bag
- twist tie
- water
- access to freezer
- ruler; pencil; paper
- large, deep tub





Procedure:

1. Create the iceberg by filling a plastic bag 2/3 full with water. Secure the top of the bag and place it in the freezer. Let it stay for 24 hours.
2. Fill the deep tub 3/4 full with water. Measure the amount of water, then refill the tub and mark the water line. Remove the iceberg from the plastic bag and measure and record its height and weight. Predict if the iceberg will sink or float and record these predictions. Students who think it will float should then predict how much of the ice will remain above water. Students should also sketch their observations.
3. Place the iceberg in the deep tub. Observe and sketch. Then mark the new water line. How might students calculate the displacement (change in level) of water? Measure (how?) and record how much ice remains above the water line. How much is below the water? Calculate and record the percentage of ice above the water's surface. Do students think the percentage of ice above water will change depending on the size of the iceberg? Test this by making different size icebergs.
4. When all tests and measurements are completed, examine the results. What statements can be made about the behavior and characteristics of icebergs? Why are icebergs dangerous for ocean traffic?

Adapted from *Date With Science* by Lynne Kepler.
Science and Children, Copyright, NSTA, February 1993.

DON'T CLOUD THE ISSUE

Objective:

Students will observe the three states of water by creating and observing a simple cloud.

Materials:

- large glass jar
- ice cubes
- water
- freezer
- electric tea kettle

THIS ACTIVITY/DEMONSTRATION REQUIRES ADULT SUPERVISION.

Procedure:

1. Ahead of the activity, make ice cubes. Have the students then observe ice cubes, the solid state of water. Place the cubes in an electric tea kettle and start to heat them. As the solid heats it turns to the liquid state of water. Pour some out before it begins to steam so students can observe this.
2. Then allow the kettle to fully boil. The empty-looking space just above or in the spout is the invisible water vapor. The steam is the immediate formation of tiny droplets of condensed water from the vapor. Do not let all the water boil away.
3. Clouds in the air also form as water vapor condenses. Demonstrate this by holding the glass jar over the steam. A cloud will form inside. As the steam in the jar cools it condenses, forming the cloud. The precipitation falls from the cloud and is liquid again. If the jar is placed in the freezer, the precipitation will become solid like snow or ice.

Adapted from *Science in a Jar* by Mary Daiopulos and Sharon Zagaria. Reprinted with permission.

WHERE HAS ALL THE WATER GONE?

Objective:

Students will explore if the amount of surface area affects **evaporation rate** of liquids.

Materials (per group):

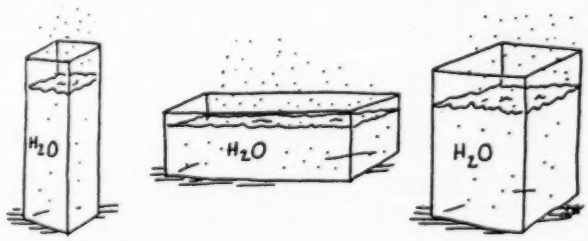
- sample graphs
- 1 waterproof graduated cylinder without lid
- 1 waterproof rectangular container without lid (vary sizes among groups)
- 1 metric ruler
- water
- scale (optional)

Teacher information for use in discussion at the *end* of the exploration:

Water exists in three forms: **solid, liquid,** and **gas.** Evaporation is the phase change of liquid to gas. This change is affected by temperature, air pressure, surface area, wind speed, and density. When water evaporates, it breaks free from the water's surface. How much water is able to break free is determined by the surface area. The greater the surface area, the more opportunity for water to break away as vapor. Encourage the students to use their own words until they have sufficient experience before introducing exact terminology.

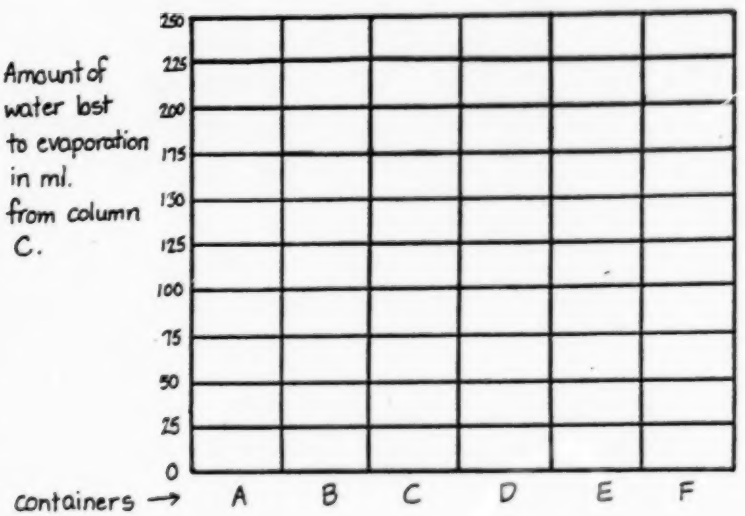
Procedure:

1. Pass out containers to the groups. Have groups determine the surface area of their containers. Record the areas of each container on chalkboard. Label the containers A-E (or however many there are) with A having the smallest opening and E having the largest. Each student should record this information.
2. Distribute a beaker with water to each group. Using the hypothesis that surface area affects the rate of evaporation, make predictions about how the area of a container will affect the rate at which the water will evaporate. Each group should then measure 250 ml of water and pour it into their container. Put all containers in a place where wind, temperature, or other variables will not affect the evaporation rate.
3. Measure the volume of water each day for 4 days and record data. Each group should share their results with the class so all students can record all the information. On the last day use the data in the total evaporated column and complete the sample bar graph (or have students make one). There is also a sample line graph to see the relationship between surface area and evaporation on page 30. Discuss results and draw conclusions about the relationship between surface area and evaporation rates.
4. The experiment can be repeated using other liquids, or other shaped containers. The **mass** of the water can be used as a measure of evaporation instead of the volume. Have some groups use mass and some use volume. The percent change should agree when compared. Use a scale to measure this way. Using the information students have gained, calculate the surface area of a swimming pool or local pond and estimate how much water is lost to evaporation.

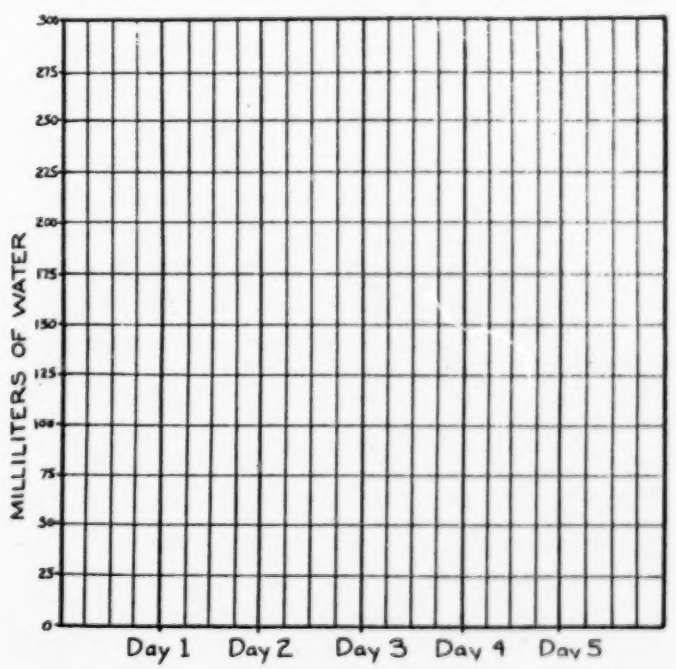


Adapted from *Water, Precious Water Book A.* Copyright AIMS Foundation, 1988.

Graph the <u>total</u> water evaporated.



container	(L x W) Area of opening	Volume of Water in Milliliters Day 1	Day 2	Day 3	Day 4	Day 5	A Beginning Volume	− B Ending Volume	= C Total Evaporated
A	cm²						250 ml		
B	cm²						250 ml		
C	cm²						250 ml		
D	cm²						250 ml		
E	cm²						250 ml		
F	cm²						250 ml		



CONTAINER KEY

A	C	E
B	D	F

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WHAT TRANSPIRED HERE?

Objective:

Students will investigate the process of **transpiration** and its connection to the water cycle. Large amounts of water are returned to the atmosphere by transpiration, the release of water from the leaf surface of plants.

Materials:

- plastic sandwich bags
- twist ties
- small pebbles
- pan balances and gram weights
- graduated cylinders
- permanent marker

Procedure:

1. Each student should place one small pebble in a bag labeled in permanent marker with their name, and then determine the mass of their bag with the pebble and a twist tie using the pan balance and gram weights. Create a data sheet with the student's name, date and beginning time of experiment, location of tree and leaf used, type of tree, weather at the time of experiment, and places for recording measurements. On this data sheet, record the mass measurement and sketch what the experiment looks like.
2. Place the bag with the pebble in it over a leaf on a deciduous tree and secure it tightly to the stem with the twist tie. Leave the bag undisturbed for 24 hours.
3. After that period observe the bag and sketch the results. Then carefully remove the bag from the stem, and quickly refasten the top with the twist tie so no moisture escapes. Measure the mass again and record the answer, time of removal, and weather on the data sheet.
4. Calculate how much water was transpired by the leaf over 24 hours by **subtracting** the two masses. A **gram of water** has a **volume of one milliliter** under standard conditions. Record the **volume** of water collected. Use the graduated cylinder to check this measurement if there is enough water.
5. Estimate the number of leaves on the tree that was used for the investigation. If more than one tree was used do this for each tree. Count the number of leaves on one or two branches and then count the number of branches and multiply for a quick estimate. Multiply that leaf estimate by the volume of water collected. Record all results on the data sheet. This is the **approximate volume of water transpired** by one tree. If more than one tree was used compare and speculate on what may have caused the difference.
6. How might varying weather conditions affect the volume of transpiration? Try the experiment on sunny days and on cloudy days and find out. Do different trees transpire different volumes of water? How can this be determined? Try the experiment on conifers (trees with needles). How might the difference in the rates of transpiration between the different types of trees be explained?
7. There are approximately 200 trees per acre in a mature deciduous (leaf not needle) forest. Calculate the volume of water that this acre of trees would transpire in 24 hours. Convert the answer from milliliters to gallons (3740 ml in a gallon). If a state water authority supplied its customers with 325 million gallons of water a day from its reservoirs, how many acres of trees transpiring would it take to meet that demand?

Adapted from *Water Wisdom.* Used by permission of the Massachusetts Water Resources Authority. 1989.

WATERSHEDDING

Objective:

Students will begin to explore the movement of water and possible pollutants through a **watershed** by creating a very simple model.

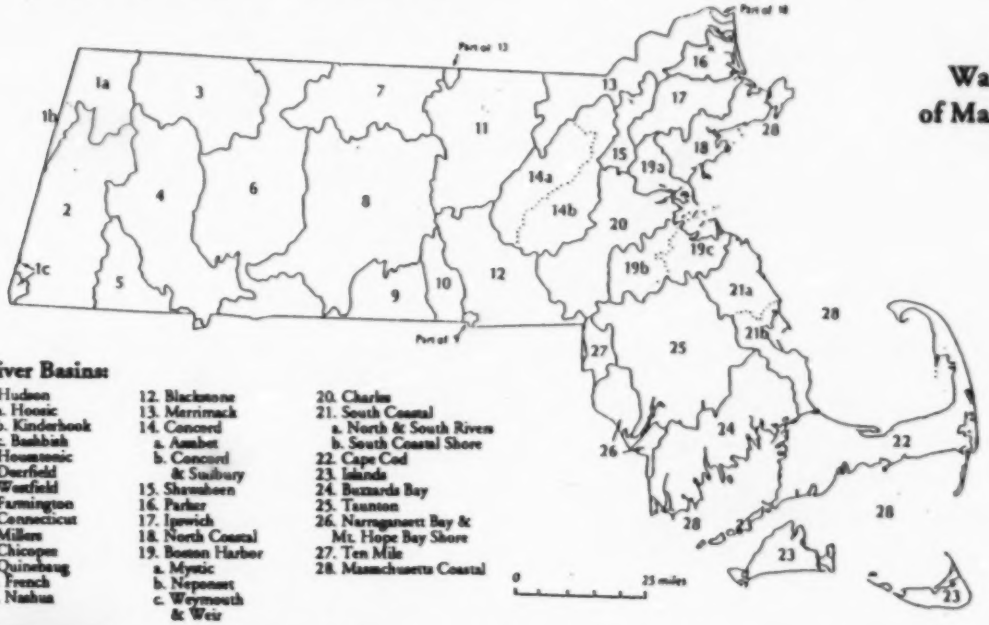
Materials:

- spray bottle
- water
- blue and red food coloring
- newspaper
- plastic tub or wash basin
- white plastic bag (24" x 30")
- paper towels

Procedure:

1. Divide students into groups and provide each group a tub and newspaper. Each student in the group should lightly crumple a sheet of newspaper and place it along the inside edge of the basin. A space should remain in the center bottom of the tub. The paper represents rocks and hillsides within a watershed.
2. Place a plastic bag over the tub and newspaper, pushing it gently down into the center, and overlapping the sides of the basin. Fill the spray bottle with water and blue food coloring. Create a rain storm by having each student in a group spray five times into the watershed. Observe the water action in the model. What was noted?
3. Place a sheet of two attached paper towels over the watershed and pushed gently down into the middle and up against the sides. The paper towel represents soil, plants, and trees in the watershed. Create another rain storm (5 sprays per student). Observe the action of the water this time. What was different? Why?
4. Place a drop of red food coloring on one paper towel hillside to represent pollution entering the system. Create a third rainstorm and observe the movement of the pollution through the watershed. What was observed? Why? How might pollution move through your own watershed? Could it affect your drinking supply?

Adapted from *Water Watcher*. Massachusetts Water Resources Authority. 1987.



Watersheds of Massachusetts

River Basins:

1. Hudson
   a. Hoosic
   b. Kinderhook
   c. Bashbish
2. Housatonic
3. Deerfield
4. Westfield
5. Farmington
6. Connecticut
7. Millers
8. Chicopee
9. Quinebaug
10. French
11. Nashua
12. Blackstone
13. Merrimack
14. Concord
   a. Assabet
   b. Concord & Sudbury
15. Shawsheen
16. Parker
17. Ipswich
18. North Coastal
19. Boston Harbor
   a. Mystic
   b. Neponset
   c. Weymouth & Weir
20. Charles
21. South Coastal
   a. North & South Rivers
   b. South Coastal Shore
22. Cape Cod
23. Islands
24. Buzzards Bay
25. Taunton
26. Narragansett Bay & Mt. Hope Bay Shore
27. Ten Mile
28. Massachusetts Coastal

GRASPING GROUNDWATER

Objective:

Students will explore the behavior of groundwater through three simple experiments. Students will observe **percolation** of water through soil and **dissolution** of soluble "pollutants;" observe the effects of **density** differences in keeping freshwater aquifers separate from saltwater aquifers underneath them; and observe the presence of a **"water table"**, zones of **aeration** and **saturation**, and the principle of a **simple well**.

Materials:

- vials or test tubes (2)
- beach sand
- coarse gravel
- eye dropper
- gravy baster
- sugar-free "Kool-Aid" (any dark-colored flavor)
- table salt
- food coloring (yellow, blue)
- 2 plastic 3 x 5 x 5 containers
- open-ended, clear plastic tube
- nylon screening (1" x 1")
- tap water
- squeeze bottle
- pencil

Procedure:

Model One: Percolation and Dissolution

1. This experiment simulates the action of rain water and sandy soil, and the dissolution of salt or another leachate such as fertilizer, herbicide, insecticide, or highway de-icer. Fill a vial or test tube with 2-3" (6cm) of beach sand.
2. Add a few ml of water from a dropper and observe as the water flows through and around the sand particles. This is **percolation**. Do not saturate the sand completely.
3. Add a layer of dark-colored, "Kool-Aid" crystals (representing a soluble pollutant) to the surface of the sand. Slowly add more water from the dropper. Observe the pollutant as it dissolves and flows (leaches) in solution through the sand. How might this same process affect groundwater near a highway where de-icer has been used? a pond near a farm where fertilizer or pesticides have been used?

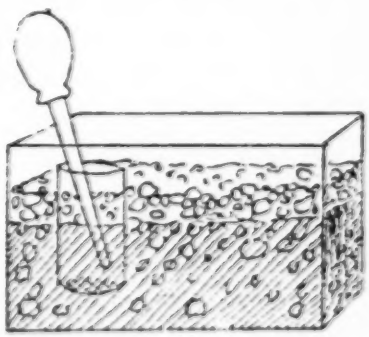
Model Two: Density

1. Prepare a concentrated solution of table salt in water and color it yellow with food coloring. Fill a test tube or vial about 1/2 full with the salt water. Using a dropper, slowly add tap water (colored blue) by allowing it to gently flow down the side of the tipped vial.
2. Observe that the blue freshwater (**lower density**) floats upon and is kept separate from the yellow saltwater (**higher density**). A narrow band of green can be observed between the blue and yellow layers. This indicates that some restricted mixing occurs. This is true in an aquifer where the soil prevents any turbulence. In underground areas near the ocean, the salt groundwater forms the floor of a freshwater aquifer.
3. Fill a second vial about 1/2 full with tap water colored blue. Using the same procedure introduce yellow saltwater to the vial. These waters mix immediately as the more dense saltwater flows into the less dense freshwater, resulting in a green mixture.

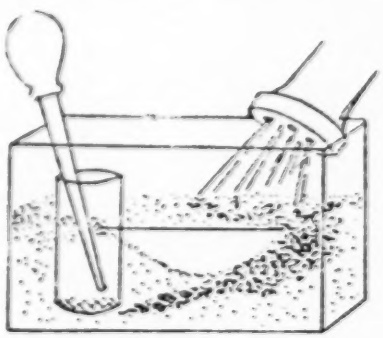
Model Three: A Water Table

1. Glue nylon screening over the bottom of a clear plastic tube as a filter. The tube will represent a "well." Place the "well" in a corner of a larger clear plastic container. Then fill the container 3/4 full with coarse gravel. Add green-colored water to the container until the level rises visibly in the gravel. Observe that the water level in the "well" matches that in the gravel. This level simulates the **water table** or the top level of groundwater. Out of doors the water table level can be seen in the level of a low-lying pond.
2. Using the baster, remove water from the "well" without hitting the filter. Observe that the water table drops. Then fill a second large container with a mixture of slightly moist sand and gravel. Place another "well" in the corner. Pour clear water through the well until a **zone of saturation** can be seen rising from the bottom. The top of this zone is the water table. Above the water table is the **zone of aeration** (the soil above the water table that is not saturated).
3. Create a depression in the zone of aeration by poking a pencil along the side of the container. Stop just above the zone of saturation. Add more water through the well until the depression begins to fill. A lowland pond has been created.
4. Place a dense spot of "Kool-Aid" crystals 2-3" away from the "well" on the surface of this sand/gravel. Add water from the squeeze bottle through the crystals. Alternate adding water this way and removing water from the "well" with the baster. Gradually the water removed will pick up the tint of the crystals. The leachate has polluted the "well" by moving through the groundwater system. The crystals were applied within the **zone of contribution** (all water in an area contributing to a well) for this "well." Water percolates more slowly through sandy gravel than through coarse pebbles.
5. How do these models simulate actual groundwater movement? Can students devise an outdoor experiment to test the principles or a model of a neighborhood with several homes each with a well? Students should also make an area survey of homes with wells. Are there any industrial or agricultural concerns near these wells? Thinking about the concept of watersheds, are any zones of contribution in common with watershed drainage areas? How might pollution affect these areas?

Coarse gravel:



Sandy gravel:



Adapted from *Groundwater Resource Guide.* Duplication permitted by Cape Cod Environmental Education Resource Center, 1990.

A SIP FOR ME, A SIP FOR YOU

Objective:

Students will explore the concept of **water allocation** within a watershed. Water is often allocated for various uses. When water is completely allocated a drought occurs. Conflicts can arise over water availability. Courts or legislation must determine "water rights."

Materials:

For pairs of students:

- 32-ounce clear, plastic soda bottle
- plastic cup showing 1-ounce measure
- masking tape
- permanent markers
- water
- paper; pencils

Procedure:

1. Calibrate the soda bottle by placing a strip of masking tape on side. Pour one ounce of water into the bottle and mark the level on the tape. Continue filling and marking the bottle until 32 ounces are marked. The water in the bottle represents the water available in their watershed.
2. Students are in charge of allocating the water for a town of 1000 households. Begin by brainstorming and agreeing upon a list of water uses such as household use, industrial use, agricultural use, or hydroelectric power use. After the list is complete add the term *minimum stream flow*. This is the amount of water needed in the streams of the watershed to serve the needs of animals, fish, and plants that live there.
3. Use the following figures for calculations:
   - Minimum stream flow = 10 ounces
   - Household Use = 1 ounce/1000 households
   - Industrial Use = 1 ounce/500 households
   - Agricultural Use = 1 ounce/500 households
   - Hydroelectric Use = 1 ounce/1000 households

   Students should then assign the number of ounces of water in their bottles (watersheds) necessary to support their town's needs. Students should calculate how much water would be used to support the 1000 households in the town (16 ounces).

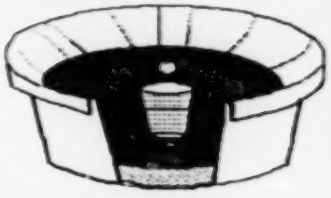
4. As water use is assigned, students should remove that amount of water from their bottles and record how much is left. Repeat calculations as the town grows: 2000 households, 3000 households, and 4000. Students should determine how large a population the watershed can sustain before it is used up. For example, 2000 x 16 ounces 32 ounces. 3000 x 16 ounces 48 ounces. Students will see that watersheds are limited as to how many people they can support.
5. Many river systems in this country are **oversubscribed**, meaning more water is taken out than the system can support. In drought years this causes many problems. Using a map of a state or the entire United States, have students look up population size and locate watersheds that might be oversubscribed and explain why. What are some possible solutions to the problem?
6. In a naturally-occurring watershed, some of the water from some uses is returned to the system. Which uses might return water: home use (most can be returned); industrial use (most can be returned, but in what condition?); agricultural use (a small portion is returned, but in what condition?); hydroelectric use (all can be returned); recreational use (some lost from large lakes in dry zones, but most returned). What water needs to be cleaned before it can be returned to the system?

Adapted from *Ecological Address: At Home in Your Watershed.* National Science & Technology Week Activity Kit. Copyright National Science Foundation, 1992-1993.

CLEAN, CLEAR WATER

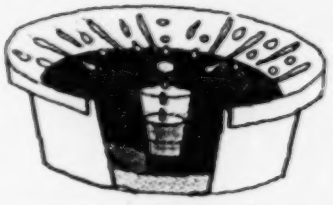
Objective:

Students will explore **distillation** by building a simple device which will clean the dirt from muddy water. Distillation is used to separate mixtures, like making fresh water out of saltwater. Survival courses teach participants to create distillation devices.



Materials:

- large pan or tub
- glass, shorter than the pan
- 2 small, clean rocks
- clear plastic food wrap to fit over tu
- masking tape
- access to sunlight



Procedure:

1. Fill the pan with 2" (5 cm) muddy water and set it in a place where the sun shines all day. Put the glass in the center of the pan and anchor it down with one rock inside it.
2. Cover the pan with clear plastic wrap, pulling it tightly (there needs to be a depression over the glass) and taping it to the outsides of the pan. Be sure it is taped firmly. Put the second rock on top of the wrap and centered over the glass. **Do not let the rock touch the glass!**
3. During the day, drops of clean water will form inside the plastic and drip into the glass. The sun heats the water and it evaporates (turns into vapor). The vapor touches the cooler wrap and condenses into water droplets. The mud doesn't evaporate and remains in the pan. The water collected in the glass will have few impurities.

Adapted from *Conservation*, Volume 4, Number 2. *Science is Elementary.* MITS, Inc. 1990.

THE BIG CLEANUP

Objective:

Students will explore the **water treatment process** by creating a mini-model. Treatment makes water safe for people to drink. In 1902, Belgium was the first country to use chlorine to clean or treat the public water supply. Water is sampled and tested throughout the treatment process to make sure the process is functioning properly. Many governments set standards for drinking water.

Materials (per group):

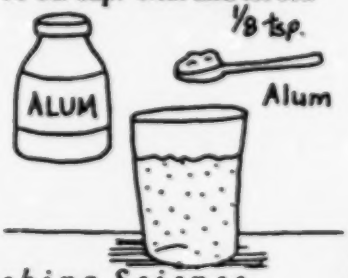
- 1 cup water mixed with 1/2 tsp. dirt
- 2 clear 10 oz. plastic cups
- 5 styrofoam cups with ten small holes poked in bottom of each
- 5 small pieces paper towel
- 1 tsp. powdered alum (available in pharmacies $2 for 4 oz. and also in supermarkets that carry canning supplies
- 1/2 to 1/3 cup clean sand, rinsed well (available in garden supply stores)
- 1/4 cup clean gravel, rinsed well (available in garden supply stores)
- 1/4 cup plant-type charcoal (available at greenhouses)
- 2 drops yellow food coloring in small amount of water (*simulated* chlorine)
- eye dropper
- coffee stirrers

Procedure:

Organize students into groups for this activity. Pass out materials to each group. **Steps in the water treatment process are simulated as follows.**

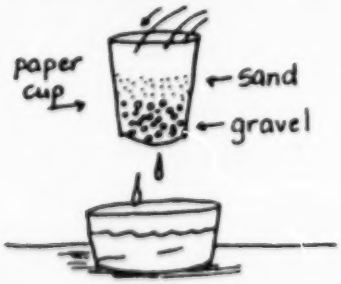
1. **Intake:** In the real process water is taken in to the treatment plant from a source, usually a reservoir. Reservoir water contains twigs, leaves, insects, etc., so it passes through screen filters to remove such debris. If the source is groundwater, "screening" naturally takes place in the soil. Sometimes very little treatment is needed for groundwater. Pass out the cups with water and dirt mixed to simulate the intake step. Natural water might not be as dirty as this.
2. **Aeration:** In the real process water is sprayed into the air to release any trapped gases and to absorb additional oxygen. Aerate the water by pouring it back and forth between the two 10 oz. cups.

3. **Coagulation:** In the real process powdered alum is dissolved in the water. It forms tiny, sticky particles called **floc**. The floc attaches to dirt particles suspended in the water. The combined weight of the dirt and floc become heavy enough to sink these newly-combined larger particles to the bottom during sedimentation. Students should mix about 1/8 teaspoon of alum into the water now collected in one 10 oz. cup. Mix and let set.



4. **Sedimentation:** In the real process the heavy particles, floc, settle to the bottom and the clear water above the particles is piped from the top. Students may have to let their cups sit overnight for sedimentation to occur.

5. **Filtration:** In the real process the clear water passes through filters made up of layers of sand, gravel, and charcoal which remove small particles. Students should poke holes in the bottoms of their five cups and place small pieces of paper toweling in the bottom of each cup. These will be stacked for a filtering system. In one cup place clean sand, in another clean gravel, and in a third place gardening charcoal. Alternately stack these with empty cups. Students should then pour the water from the 10 oz. cup through the filter and into the second 10 oz. cup (now well-rinsed out).



6. **Chlorination:** In the real process a small amount of chlorine gas is added to the filtered water to kill any bacteria or microorganisms that may be in the water, improve taste and odor, and help settle solids still in the water. In some groundwater-source systems, this is the only treatment provided. Students will *simulate* this by adding a drop of yellow-colored water to their "treated" water.

7. **Storage:** In the real process water is placed in a closed tank called a clear well. This allows time for the chlorine to mix throughout the water in order for disinfection to take place. The water then flows into the distribution system.

8. After all groups have completed the process compare the water samples. Are any cleaner than others? What would have happened if the steps were completed in a different order? Repeat the treatment process using different filters, more filters, or another combination of filtering materials. What were the results? Groups might later research local reservoirs and water treatment facilities, and trace the water distribution system on their city or town maps. Which reservoirs serve which areas? How are water treatment facilities located in relation to their water sources? How are water treatment facilities located in a watershed? How do public water sources relate to watersheds? What are the local water quality standards set by your state? Try to get someone from the community water department to speak to the students.

Reprinted from The Story of Drinking Water.
Copyright 1990, American Water Works Association.

WATER, WATER EVERYWHERE??

Objective:

Students will increase their awareness of the need for **water conservation** by exploring what life is like for many world populations with limited fresh water supplies. Our bodies need **2.4 liters of water** a day. An average family of four uses **265 liters of water daily**, 255 liters more than is needed to sustain life. (A liter weighs 0.994 kilograms.)

Materials:

- water buckets or other carrying tools
- water
- calculators
- weight scale
- school yard area with some distance
- paper; pencils

Procedure:

1. Perform some calculations using the above information. How much water does each student's family use each day by weight in kilograms? On average, a family of four uses 263 kilograms (265 liters x .994 kg/liter = 263.41 kg).
2. Have each student lift and carry 1, then 2, then 3, then 4 liters across a small area. How hard was it? How long could students carry the water for? Discuss measuring the amount of water a family would need daily for various activities such as drinking, cooking, bathing, gardening, and cleaning.
3. Have students research world areas that have limited water clean supplies. Most third world areas have one central, fresh water supply that is often located at some distance from the village or settlement. For this activity, imagine that the classroom/village water supply is 1.6 kilometers away. As is the case in most villages, both parents work in the fields so children are responsible for carrying as much water as the family needs. How much time would it take for each student to carry enough water for his or her family's needs? Take into consideration: a) the amount of water each student is able to carry, b) the amount each family needs, and c) how fast the student can walk to the water source and back without wasting time.
4. Set up a water brigade from an outdoor faucet to the farthest area of the school for 1/2 hour. Do students have a better understanding of what it is like to be responsible for the family's survival this way? Do they better understand the need for conservation of water? Students might inventory water use at home and suggest better conservation measures for their families to implement. Local water authorities can make valuable conservation suggestions as well. Students might also create an inventory for their neighborhoods, to determine water use and what conservation measures are presently in place. Research water conservation methods around the world.
5. Have students work in pairs to devise better water-carrying devices with the following limitations:
   - water splashes—effective containers reduce splash
   - container must be light, leakproof, and clean
   - only fresh water source is 1.6 kilometers away
   - use of animals is allowed, but their water needs must be met as well
   - rain, ice, or snow may be used, but must be purified (average rain/snowfall amount?)
   - no motors allowed

Adapted from *Conservation*, Volume 4, Number 2, *Science is Elementary*. MITS, Inc.

CAN WATER BE STRETCHED?

Objective:

The students will be able to state a means whereby water can be recycled and thus conserved.

Materials:

- Newsprint
- Tape
- Strips of paper

Teacher Information:

As ground water across the country dwindles and/or becomes polluted, an understanding of the need to conserve and recycle the potable water becomes essential. In this activity absurdities that may occur become realities if we do not become more conscious of our water use habits.

Procedure:

1. Brainstorm water uses with the class.

Some possibilities to consider for a water use list:

- Drinking water
- Indoor plants
- Bathing
- Humidifier
- Shampoos
- Hot water pipes
- Car wash
- Radiators
- Swimming pools
- Gardens
- Lawns
- Street cleaning
- Making pottery
- Cooking and food ingredients (soups, jello, etc.)
- Sewage system
- Water bed
- Laundromat
- Brushing teeth
- Washing dishes
- Air conditioning
- Floor wash
- Fire control
- Mix for paint, water colors
- Farm irrigation
- Sailing, boating
- Industrial products
- Skating
- Toilet
- Drink ingredients (coffee, Kool-Aid, tea, etc.)
- Surfing
- Home and drink for animals

3. Explain that the class is to pretend that there has been very little rain this year and the water supply is limited. As a result each family gets a ration of one gallon of water per day per family member. In order to meet as many of the water needs as possible, the students must decide the use to which they put their ration. Then they are going to discover ways of stretching the water to meet more uses.
4. The class will now decide on how many essential needs could be met by a six-gallon ration for a family. Distribute the strips of paper and have the members of the class write one of the essential uses on each strip. Consider how much should be set aside for drinking. With the remainder of the ration have the students

tape other essential uses on the wall in an order that will permit the water to be used for as many functions as possible. The taped signs can be juggled around as new plans occur. Try to get some agreement on the most essential needs. This can be done as either a whole class or small group activity.

One bucket of water might serve for brushing teeth, then boiling eggs, then a bath, then washing clothes, followed by washing the kitchen floor and then the car and finally end up watering the garden.

5. After all the essential needs are taken care of, see how many uses from the other categories could be inserted into the list of functions.
6. Ask the students how they would feel if they knew that they had only one gallon of water for the day. Is that scary? Can they plan what to do? Would they like to have to live that way? Suggest that we should all save water now. Ask for ways the students could help, such as shutting water faucets off tightly, taking quick showers or not filling the bath tub more than a couple of inches, and putting a bulky object in the toilet tank so that not as much is used for flushing.

Adapted from *Boston Environment: Land and People* by Arlene Nichols, 1978.

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Volume 4
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Volume 6

Sample Contents

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- Brief Brief •
- Trade Secrets •
- Book Looking •
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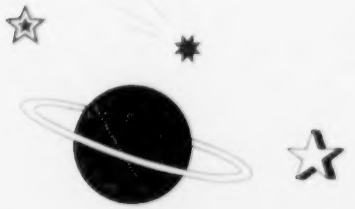
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